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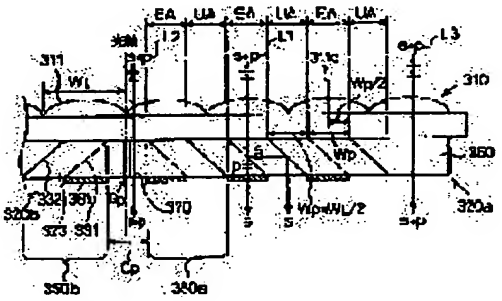
(54) OPTICAL ELEMENT, POLARIZED LIGHT ILLUMINATING DEVICE, AND PROJECTION TYPE DISPLAY DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To improve the light application efficiency of an optical element.
SOLUTION: A polarization conversion element for converting incident light into linear polarized light in a prescribed polarizing direction and projecting the converted light, arranges two polarization converting element arrays 320a, 320b arranged along at least one of the row and column directions of lens arrays in mutually opposed state a prescribed interval Cp formed almost at the center in the array direction of the projection face of a lens array 310. A luminous flux L2 passing through the prescribed interval Cp without being made incident on the array 320a out of light beams (s-polarized light + p- polarized light) converged by the lens array 310 and projected, includes the prescribed polarized light (s-polarized light) to be originally projected and the invalid polarized light (p-polarized light). Only necessary polarized light out of projected light passed through the interval Cp can be utilized as a valid luminous flux by arranging a polarizing plate or the like on the projection face side of the interval Cp.



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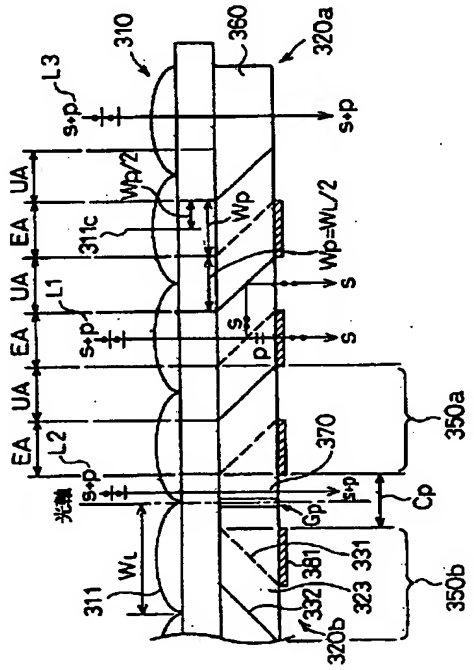
(54)【発明の名称】　光学素子、偏光照明装置および投写型表示装置

(57)【要約】

【課題】　光学素子の光の利用効率を向上させる。

【解決手段】　入射光を所定の偏光方向の直線偏光光に変換して出射する偏光変換素子が、レンズアレイの行方向と列方向の少なくとも一方である配列方向に沿って複数配置された２つの偏光変換素子アレイ３２０ａ，３２０ｂを、レンズアレイ３１０の出射面の配列方向のほぼ中心に設けられた所定の間隔Ｃｐを挟んで反対向きに配置する。レンズアレイ３１０で集光されて出射した光束（ｓ偏光光＋ｐ偏光光）のうち、偏光変換素子アレイ３２０ａに入射せずに所定の間隔Ｃｐを通過する光束Ｌ２は、本来出射するべき所定の偏光光（ｓ偏光光）および無効な偏光光（ｐ偏光光）を含む光束である。そして、この間隔Ｃｐを通過する出射光のうち、必要な偏光光のみを、この間隔Ｃｐの出射面側に偏光板等を設けるにより、有効な光束として利用することが可能である。



【特許請求の範囲】
【請求項１】　偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、
前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、
前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする光学素子。
【請求項２】　請求項１において、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側に、前記偏光分離面、前記反射面のいずれも存在しないダミー領域を、透光性部材により形成したことを特徴とする光学素子。
【請求項３】　請求項１または２において、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側ではない側に、前記偏光分離面、前記反射面のいずれも存在しない領域を、透光性部材により形成したことを特徴とする光学素子。
【請求項４】　複数のレンズがマトリクス状に配置されたレンズアレイと、
前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、
前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、
前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする光学素子。
【請求項５】　請求項４において、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側に、前記偏光分離面、前記反射面のいずれも存在しないダミー領域を、透光性部材により形成したことを特徴とする光学素子。
【請求項６】　請求項５において、
前記ダミー領域の前記所定の間隔側の角部が取り除かれていることを特徴とする光学素子。
【請求項７】　請求項４ないし６のいずれかにおいて、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側ではない側に、前記偏光分離面、前記反射面のいずれも存在しない領域を、透光性部材により形成したことを特徴とする光学素子。
【請求項８】　請求項４ないし７のいずれかにおいて、
前記偏光変換素子アレイの光入射面に沿った前記偏光分離面と前記反射面との配列ピッチが、前記偏光分離面及び前記反射面の配列方向に沿った前記レンズアレイの配列ピッチの１／２よりも大きいことを特徴とする光学素子。
【請求項９】　光源部と、
前記光源部からの光を１種類の偏光光に変換して出射する光学素子と、を備え、
前記光学素子は、
複数のレンズがマトリクス状に配置されたレンズアレイと、
前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、
前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、
前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする偏光照明装置。
【請求項１０】　請求項９において、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側に、前記偏光分離面、前記反射面のいずれも存在しないダミー領域を、透光性部材により形成したことを特徴とする偏光照明装置。
【請求項１１】　請求項１０において、
前記ダミー領域の前記所定の間隔側の角部が取り除かれていることを特徴とする偏光照明装置。
【請求項１２】　請求項９ないし１１のいずれかにおいて、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側ではない側に、前記偏光分離面、前記反射面のいずれも存在しない領域を、透光性部材により形成したことを特徴とする偏光照明装置。
【請求項１３】　請求項９ないし１２のいずれかにおいて、
前記レンズアレイから出射される光の分布に合わせて前記偏光分離面を配列したことを特徴とする偏光照明装置。
【請求項１４】　請求項９ないし１３のいずれかにおいて、
前記２つの偏光変換素子アレイの前記所定の間隔側に最も近い位置には偏光分離面が配置され、この偏光分離面の中心は、前記レンズアレイの複数のレンズのうち、前記偏光分離面と最も近い位置に配置されているレンズの中心軸よりも前記所定の間隔側に配置されていることを特徴とする偏光照明装置。
【請求項１５】　請求項９ないし１４のいずれかにおいて、
前記偏光変換素子アレイの光入射面に沿った前記偏光分

離面と前記反射面との配列ピッチが、前記偏光分離面及び前記反射面の配列方向に沿った前記レンズアレイの配列ピッチの１／２よりも大きいことを特徴とする偏光照明装置。

【請求項１６】　偏光照明装置と、
前記偏光照明装置からの出射光を与えられた画像信号に基づいて変調する変調手段と、
前記変調手段により変調された光束を投写する投写光学手段と、を備え、
前記偏光照明装置は、
光源部と、
前記光源部から入射する入射光を所定の偏光方向の光に変換して出射する光学素子と、を備え、
前記光学素子は、
複数のレンズがマトリクス状に配置されたレンズアレイと、
前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、
前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、
前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする投写型表示装置。

【請求項１７】　請求項１６において、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側に、前記偏光分離面、前記反射面のいずれも存在しないダミー領域を、透光性部材により形成したことを特徴とする投写型表示装置。

【請求項１８】　請求項１７において、
前記ダミー領域の前記所定の間隔側の角部が取り除かれていることを特徴とする投写型表示装置。

【請求項１９】　請求項１６ないし１８のいずれかにおいて、
前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側ではない側に、前記偏光分離面、前記反射面のいずれも存在しない領域を、透光性部材により形成したことを特徴とする投写型表示装置。

【請求項２０】　請求項１６ないし１９のいずれかにおいて、
前記レンズアレイから出射される光の分布に合わせて前記偏光分離面を配列したことを特徴とする投写型表示装置。

【請求項２１】　請求項１６ないし２０のいずれかにおいて、
前記２つの偏光変換素子アレイの前記所定の間隔側に最も近い位置には偏光分離面が配置され、この偏光分離面の中心は、前記レンズアレイの複数のレンズのうち、前記偏光分離面と最も近い位置に配置されているレンズの中心軸よりも前記所定の間隔側に配置されていることを特徴とする投写型表示装置。

【請求項２２】　請求項１６ないし２１のいずれかにおいて、
前記偏光変換素子アレイの光入射面に沿った前記偏光分離面と前記反射面との配列ピッチが、前記偏光分離面及び前記反射面の配列方向に沿った前記レンズアレイの配列ピッチの１／２よりも大きいことを特徴とする投写型表示装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】この発明は、入射された光を所定の偏光光束に変換する光学素子、このような光学素子を備えた偏光照明装置および投写型表示装置に関する。

【０００２】

【従来の技術】投写型表示装置の照明光学系には、光の利用効率を高めて明るい表示を得るために、ランダムな偏光方向を有する光を、一方向の偏光方向を有する光に変換して使用する方法が用いられている。このような、ランダムな偏光方向を有する光を、一方向の偏光方向を有する光に変換する光学素子（偏光変換素子）としては、特開平７－２９４９０６号公報に記載されたものが知られている。図１４は、このような光学素子の平面図である。この光学素子は、偏光分離膜３６を有する線状の偏光ビームスプリッタ３０と、反射膜４６を有する線状のプリズム４０とを交互に貼り合わせた偏光ビームスプリッタアレイ２０を備えている。また、偏光ビームスプリッタアレイ２０の光の入射面には複数の集光レンズで構成されるレンズアレイ１０を備え、光の出射面の一部には、λ／２位相差板２４が選択的に設けられている。

【０００３】図１４（Ａ）に示すように、レンズアレイ１０に入射された光束は、レンズアレイ１０によって集光されて、複数の分割光束（中間光束）に変換され、レンズアレイ１０に対応して配置される偏光ビームスプリッタ３０に、ｓ偏光成分とｐ偏光成分とを含む入射光として入射される。この入射光は、まず、偏光分離膜３６によってｓ偏光光とｐ偏光光とに分離される。ｓ偏光光は、光入射面に対して４５度をなす偏光分離膜３６によってほぼ垂直に反射され、光入射面に対して４５度をなす反射膜４６によってさらに垂直に反射されて、プリズム４０から出射される。一方、ｐ偏光光は、偏光分離膜３６をそのまま透過し、λ／２位相差板２４によってｓ偏光光に変換されて出射される。従って、この光学素子は、入射したランダムな偏光方向を有する光束を、すべてｓ偏光光束に変換して出射する素子である。

【０００４】

【発明が解決しようとする課題】レンズアレイ１０に入射された光束は、レンズアレイ１０を構成する各集光レンズによって集光されて、各集光レンズに対応する偏光ビームスプリッタに、すべての光束が入射することが理想的である。しかしながら、現実のレンズアレイ１０に入射された光束には、図１４（Ｂ）に示すように、完全に集光されずにプリズム４０に入射する光束が存在する。このような、プリズム４０に入射した光束は、反射膜４６で全反射して隣に配置された偏光ビームスプリッタ３０に入射する。そして、偏光ビームスプリッタ３０に入射した光束は、偏光分離膜３６によってｓ偏光光とｐ偏光光とに分離される。分離されたｓ偏光光は、偏光分離膜３６で反射し、λ／２位相差板２４によってｐ偏光光に変換されて出射する。また、ｐ偏光光は、偏光分離膜３６を透過して透過方向に配置されたプリズム４０の反射膜４６で反射して出射する。従って、この光学素子に入射した光束は、ｓ偏光光の単一光束ではなく、ｐ偏光光束も含んだ光束に変換されて出射することになる。ここで、偏光変換素子の入射領域は、有効入射領域ＥＡと無効入射領域ＵＡとに分けられる。有効入射領域ＥＡは、入射された光束が所望の偏光光に変換されて出射される偏光変換素子の入射領域をいう。また、無効入射領域ＵＡは、入射された光束が所望ではない偏光光に変換されて出射される偏光変換素子の入射領域をいう。したがって、本従来例では、複数の偏光ビームスプリッタ３０の入射面が有効入射領域ＥＡであり、複数のプリズム４０の入射面が無効入射領域ＵＡとなる。

【０００５】一種類の偏光光のみを利用することが望まれている場合には、このような無効入射領域ＵＡに入射される光を偏光板等でカットしなければならない。すなわち、このような場合に、上述のｐ偏光光の出射光は利用されないため、光の利用効率が低下してしまうという課題があった。

【０００６】この発明は、従来技術における上述の課題を解決するためになされたものであり、偏光照明装置や投写型表示装置で使用される光学素子の光の利用効率を向上させる技術を提供することを目的とする。

【０００７】

【課題を解決するための手段およびその作用・効果】上述の課題を解決するため、第１の発明は、光学素子であって、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする。

【０００８】偏光変換素子アレイの光の入射面は、入射光が偏光分離膜面に直接入射する第１の領域と、反射面に直接入射する第２の領域とに分けられる。このうち第１の入射領域に入射した光は、所定の１種類の偏光光（有効な偏光光）に変換されるが、第２の入射領域に入射した光は、それとは異なった無効な偏光光に変換される。上記第１の発明の構成によれば、所定の間隔を通過する光は、第２の領域に入射されることはないので、無効な偏光光に変換されずにランダムな偏光光のままで光学素子から出射する。したがって、このような所定の間隔を通過するランダムな偏光光に含まれる有効な偏光光も利用することができるため、光学素子の光の利用効率を高めることができる。

【０００９】ここで、前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側に、前記偏光分離面、前記反射面のいずれも存在しないダミー領域を、透光性部材により形成することが好ましい。

【００１０】このようにすれば、偏光変換素子アレイを通過する光束と、所定の間隔を通過する光束の光路長を近付けることができる。また、２つの偏光変換素子アレイのそれぞれの両端部のうち、所定の間隔側の端面で反射した光束は、反射の方向によっては有効に照射面を照射できず、光を有効に利用できないこともある。上記のように構成にすれば、この問題を緩和することができる。

【００１１】また、前記２つの偏光変換素子アレイのそれぞれの両端部のうち、前記所定の間隔側ではない側に、前記偏光分離面、前記反射面のいずれも存在しない領域を、透光性部材により形成してもよい。

【００１２】第１の発明の光学素子は、一般には、その中心が、配置された２つの変換素子アレイの中間、すなわち所定の間隔内に設定され、光源の光軸上にその中心を一致させて用いられる。一方、光源の出射光は、一般には、光源の光軸から離れるほど弱くなる傾向にあり、２つの偏光変換素子アレイの所定の間隔側ではない側の端部に入射される光を所定の１種類の偏光光に変換しても、光の利用効率上ほとんど効果がない。したがって、上記のような構成にすれば、偏光分離面や反射面を減らすことができるので、安価な光学素子を実現できる。

【００１３】第２の発明は、光学素子であって、複数のレンズがマトリクス状に配置されたレンズアレイと、前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向

かい合うように配置されてなることを特徴とする。
【００１４】第２の発明においても、上記第１の発明と同様に、偏光変換素子アレイの光の入射面は、入射光が偏光分離膜面に直接入射する第１の領域と、反射面に直接入射する第２の領域とに分けられる。レンズアレイで集光された光束は、すべて第１の領域に入射されることが好ましいが、第２の領域に入射される光束も存在する。上記第２の発明の構成によれば、レンズアレイから出射した光束のうち、偏光変換素子アレイに入射せずに所定の間隔を通過する光束は、第２の領域に入射されることはないので、無効な偏光光に変換されずにランダムな偏光光のままで光学素子から出射する。したがって、このような所定の間隔を通過するランダムな偏光光に含まれる有効な偏光光も利用することができるため、光学素子の光の利用効率を高めることができる。
【００１５】ここで、前記偏光変換素子アレイの光入射面に沿った前記偏光分離面と前記反射面との配列ピッチが、前記偏光分離面及び前記反射面の配列方向に沿った前記レンズアレイの配列ピッチの１／２よりも大きいことが好ましい。
【００１６】上記構成によれば、レンズアレイから出射した光束がより効率よく入射するように偏光変換素子アレイを構成できるため、光学素子の光の利用効率を高めることができる。
【００１７】第３の発明は、偏光照明装置であって、光源部と、前記光源部からの光を１種類の偏光光に変換して出射する光学素子と、を備え、前記光学素子は、複数のレンズがマトリクス状に配置されたレンズアレイと、前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする。
【００１８】第３の発明によれば、光の利用効率の高い光学素子を使用しているので、照明装置の光の利用効率を高めることができる。
【００１９】また、前記レンズアレイから出射される光の分布に合わせて前記偏光分離面を配列することが好ましい。
【００２０】このようにすれば、レンズアレイから出射される光を有効に利用することができるため、照明装置の光の利用効率をさらに向上させることができる。
【００２１】さらに、前記２つの偏光変換素子アレイの前記所定の間隔側に最も近い位置には偏光分離面が配置され、この偏光分離面の中心は、前記レンズアレイの複数のレンズのうち、前記偏光分離面と最も近い位置に配置されているレンズの中心軸よりも前記所定の間隔側に配置されることが好ましい。
【００２２】光源の出射光は、光源の光軸付近の光量が多い。また、光源光軸付近から出射される光の光量分布は、２つの偏光変換素子アレイの所定の間隔側に最も近い位置に配置された偏光分離面と最も近い位置に配置されているレンズの中心軸よりも光源光軸側に偏っている。したがって、上記のような構成によれば、この光源光軸付近の光を有効に利用することができるため、照明装置の光の利用効率をさらに向上させることができる。
【００２３】第４の発明は、投写型表示装置であって、偏光照明装置と、前記偏光照明装置からの出射光を与えられた画像信号に基づいて変調する変調手段と、前記変調手段により変調された光束を投写する投写光学手段と、を備え、前記偏光照明装置は、光源部と、前記光源部から入射する入射光を所定の偏光方向の光に変換して出射する光学素子と、を備え、前記光学素子は、複数のレンズがマトリクス状に配置されたレンズアレイと、前記レンズアレイの一方の面に固定され、偏光方向がランダムな偏光光を１種類の偏光光に変換する２つの偏光変換素子アレイを有し、前記偏光変換素子アレイのそれぞれは、偏光方向がランダムな偏光光を２種類の直線偏光光に分離する偏光分離面と、前記偏光分離面により分離された直線偏光光のうち一方を反射する反射面とを備え、前記偏光分離面と前記反射面とは透光性部材を介して交互に複数配列され、前記２つの偏光変換素子アレイは、所定の間隔を隔て、かつ互いの前記偏光分離面が向かい合うように配置されてなることを特徴とする。
【００２４】第４の発明によれば、光の利用効率の高い光学素子を用いた照明装置を使用しているので、投写面上に投写される映像を明るくすることができる。
【００２５】
【発明の実施の形態】次に、本発明の実施の形態を実施例に基づき説明する。
【００２６】Ａ．偏光照明装置：図１は、本発明の実施例を適用する偏光照明装置５０の要部を平面的にみた概略構成図である。この偏光照明装置５０は、光源部６０と、偏光発生装置７０とを備えている。光源部６０は、ｓ偏光成分とｐ偏光成分とを含むランダムな偏光方向の光束を出射する。光源部６０から出射された光束は、偏光発生装置７０によって偏光方向がほぼ揃った一種類の直線偏光光（例えば、ｓ偏光光）に変換されて、照明領域８０を照明する。
【００２７】光源部６０は、光源ランプ１０１と、放物面リフレクター１０２とを備えている。光源ランプ１０１から放射された光は、放物面リフレクター１０２によって一方向に反射され、略平行な光束となって偏光発生装置７０に入射する。
【００２８】偏光発生装置７０は、第１の光学要素２０

０と、第２の光学要素４００とを備えている。図２は、第１の光学要素２００の斜視図である。第１の光学要素２００は、矩形状の輪郭を有する微小な光束分割レンズ２０１が、縦方向にM行、横方向に２N列のマトリクス状に配列された構成を有している。従って、レンズ横方向中心ＣＬからは、左方向にN列、右方向にN列存在する。この例では、Ｍ＝１０，Ｎ＝４である。第１の光学要素２００は、光軸が第１の光学要素２００の中心に一致するように配置されている。各光束分割レンズ２０１をＺ方向から見た外形形状は、照明領域８０の形状と相似形をなすように設定されている。本実施例では、ｘ方向に長い横長の照明領域８０を想定しているため、光束分割レンズ２０１のＸＹ平面上における外形形状も横長である。

【００２９】図１の第２の光学要素４００は、光学素子３００と出射側レンズ３９０とを備えている。そして、光学素子３００および出射側レンズ３９０は、その中心が光軸と一致するように配置されている。

【００３０】光学素子３００は、集光レンズアレイ３１０と２つの偏光変換素子アレイ３２０ａ，３２０ｂとを備えている。集光レンズアレイ３１０は、第１の光学要素２００と同じ構成のレンズアレイで、相対する向きに配置される。集光レンズアレイ３１０は、第１の光学要素２００とともに、各光束分割レンズ２０１で分割された複数の分割光束を集光する役割を有する。偏光変換素子アレイ３２０ａ，３２０ｂは、入射された光束を１種類の直線偏光光（例えば、ｓ偏光光やｐ偏光光）に変換して出射する役割を有する。図３は、偏光変換素子アレイ３２０ｂ（３２０ａ）の基本動作を示す説明図である。偏光変換素子の入射面に、ｓ偏光成分とｐ偏光成分とを含むランダムな偏光方向を有する入射光が入射する。この入射光は、まず、偏光分離膜３３１によってｓ偏光光とｐ偏光光に分離される。ｓ偏光光は、偏光分離膜３３１によってほぼ垂直に反射され、反射膜３３２によってさらに垂直に反射されてから出射される。一方、ｐ偏光光は、偏光分離膜３３１をそのまま透過する。偏光分離膜を透過したｐ偏光光の出射面には、λ／２位相差板３８１が配置されており、このｐ偏光光がｓ偏光光に変換されて出射する。従って、偏光変換素子を通過した光は、そのほとんどがｓ偏光光となって出射される。また、偏光変換素子から出射される光をｐ偏光光としたい場合には、λ／２位相差板３８１を、反射膜３３２によって反射されたｓ偏光光が出射する出射面に配置するようにすればよい。なお、本発明は、光学素子３００に特徴を有するものであり、詳細については後述する。

【００３１】図１の出射側レンズ３９０は、光学素子３００から出射される複数の分割光束（偏光変換素子アレイ３２０ａ，３２０ｂによって変換された直線偏光光の分割光束）がすべて照明領域８０を照射するように重畳する役割を有する。

【００３２】光源部６０から出射されて第１の光学要素２００に入射した光束は、それぞれの光束分割レンズ２０１によって中間光束２０２に分割される。中間光束２０２は、光束分割レンズ２０１と集光レンズ３１１の集光作用によって、光軸と垂直な平面内（図１ではＸＹ平面）で収束する。中間光束２０２が収束する位置には、光束分割レンズ２０１の数と同数の光源像が形成される。なお、光源像が形成される位置は、偏光変換素子アレイ３２０ａ，３２０ｂ内の偏光分離膜３３１（図３参照）の近傍である。

【００３３】光学素子３００に入射された光束のうち、集光レンズアレイ３１０で集光されて偏光分離膜３３１を照射した光束は、１種類の直線偏光光に変換されて出射される。光学素子３００から出射された光束は、出射側レンズ３９０によって照明領域８０を照明する。照明領域８０は、多数の光束分割レンズ２０１で分割された多数の光束で照明されるので、照明領域８０の全体をむらなく照明することができる。

【００３４】Ｂ．第１実施例：図４は第１実施例である光学素子３００の光の入射面を示す正面図、図５は出射面を示す背面図、図６は図５のＡ－Ａ’断面図、図７は側面図を示している。

【００３５】この光学素子３００は、集光レンズアレイ３１０の平坦な光出射面に、２つの偏光変換素子アレイ３２０ａ，３２０ｂが光学接着剤で貼り合わされたものである。２つの偏光変換素子アレイ３２０ａ，３２０ｂは、集光レンズアレイ３１０の横方向中心ＣＬを基準に、所定の間隔Ｃｐを挟んで左右に反対向きに配置されている。この所定の間隔Ｃｐについては後述する。集光レンズアレイ３１０は、第１の光学要素２００（図２）と同様に略矩形状の輪郭を有する集光レンズ３１１が、たて方向にM行、よこ方向には２N列のマトリクス状に配列された構成を有している。従って、レンズ横方向の中心ＣＬからは、左方向にN列，右方向にN列存在する。この例では、Ｍ＝１０，Ｎ＝４である。

【００３６】図８は、偏光変換素子アレイ３２０ａ，３２０ｂの構成を示す斜視図である。この偏光変換素子アレイ３２０ａ，３２０ｂは、偏光ビームスプリッタアレイ３４０と、偏光ビームスプリッタアレイ３４０の光出射面の一部に選択的に配置されたλ／２位相差板３８１（図中斜線で示す）とを備えている。偏光ビームスプリッタアレイ３４０は、それぞれ断面が平行四辺形の柱状の複数の透光性部材３２３が、順次貼り合わされた形状を有している。透光性部材３２３の界面には、偏光分離膜３３１と反射膜３３２とが交互に形成されている。λ／２位相差板３８１は、偏光分離膜３３１あるいは反射膜３３２の光の出射面のｘ方向の写像部分に、選択的に配置される。この例では、偏光分離膜３３１の光の出射面のｘ方向の写像部分にλ／２位相差板３８１を選択配置している。

【００３７】先に図３を用いて説明したように、偏光分離膜３３１に入射された入射光は、偏光分離膜３３１を透過し、λ／２位相差板３８１により所定の直線偏光光に変換されて出射する直線偏光光と、偏光分離膜３３１で反射し、反射膜３３２で反射して出射する所定の直線偏光光とに分離される。従って、隣り合う１つの偏光分離膜３３１および１つの反射膜３３２を含み、さらに１つのλ／２位相差板３８１で構成される１つのブロックを、１つの偏光変換素子３５０とみなすことができる。偏光変換素子アレイ３２０ａ，３２０ｂは、このような偏光変換素子３５０が、ｘ方向に複数列配列されたものである。この実施例では、集光レンズアレイ３１０の片側の列方向の数Ｎは４であるため、片側には原則として４列の偏光変換素子３５０が構成されている。ただし、４列めの偏光変換素子に相当する部分３６０は、偏光分離膜３３１も反射膜３３２も有さず、透光性部材のみで構成されている。以下、説明上、この部分３６０を透光部と呼ぶこととする。また、この透光部３６０については後述する。

【００３８】図８において、一番左側の列の偏光変換素子３５０の側面（端面）部分には、透光性部材で構成されるダミー部３７０が設けられている。また、ダミー部３７０の光の入射面（接着面）側の端部３７２は、角を丸くしたり、角をとったりされている。これらの理由は後で説明する。

【００３９】図９は、偏光ビームスプリッタアレイ３４０の製造例を示す説明図である。この偏光ビームスプリッタアレイ３４０は、偏光分離膜３３１と反射膜３３２とが交互に配置されるように、例えば、偏光分離膜３３１と反射膜３３２とが形成された板ガラス３２１と、何も形成されていない板ガラス３２２とを接着剤３２５により交互に貼り合わせる。この際、貼り合わせの最初と最後には、板ガラス３２２と異なる厚さの板ガラス３２２ｂ（ダミー部３７０（図８））および３２２Ｃ（透光部３６０（図８））を貼り合わせる。こうすれば、ダミー部３７０および透光部３６０を形成することができる。こうして互いに接着された複数の透光性部材３２１，３２２，３２２ｂ，３２２ｃを、その表面と所定の角度θをなす切断面（図中、破線で示す）でほぼ平行に切断することによって、透光性ブロックが切り出される。θの値は、約４５度とすることが好ましい。また、両端の突出した部分を切断して略直方体形状とする。こうして切り出された透光性ブロックの表面（切断面）を研磨することによって、偏光ビームスプリッタアレイ３４０（図８）を得ることができる。なお、この明細書においては、透光性板材（透光性部材）を「基板」とも呼び、また、複数の透光性板材を貼り合わせたブロックや、これから切り出されたブロックを「基板ブロック」とも呼ぶ。

【００４０】図１０は、図５に示すＡ－Ａ’断面の一部拡大図である。偏光変換素子アレイ３２０ａ，３２０ｂはレンズ中心に対して反対向きに対称な位置に配置されているだけで、その機能は全く同じであるため、以下では偏光変換素子アレイ３２０ａについて説明する。偏光変換素子アレイ３２０ａの光の入射面は、偏光分離膜３３１へ入射して有効な偏光光に変換される光が入射する有効入射領域ＥＡ（偏光分離膜３３１に対応する光の入射面）と、反射膜３３２に入射して、無効な偏光光に変換される光が入射する無効入射領域ＵＡ（反射膜３３２に対応する光の入射面）とが、交互に配置されている。この有効入射領域ＥＡおよび無効入射領域ＵＡのｘ方向の大きさWp は、集光レンズ３１１のｘ方向の大きさＷＬの１／２に等しくしている。また、集光レンズ３１１の中心３１１ｃは、有効入射領域ＥＡのｘ方向の中心と等しくなるように配置されている。ここでは、偏光変換素子で変換されて利用される有効な偏光光をｓ偏光光とする。

【００４１】集光レンズアレイ３１０で集光された光（ｓ偏光成分とｐ偏光成分とを含むランダムな偏光方向を有する光）は、偏光変換素子アレイ３２０ａに入射する。このような入射光のうち有効入射領域ＥＡに入射する光束Ｌ１は、先に図３を用いて説明したように、偏光分離膜３３１でｓ偏光光とｐ偏光光に分離される。ｓ偏光光は、偏光分離膜３３１で反射し、さらに反射膜３３２で反射して出射する。ｐ偏光光は、偏光分離膜３３１を透過し、さらにλ／２位相差板３８１でｓ偏光光に変換されて出射する。従って、偏光変換素子アレイ３２０ａの有効入射領域ＥＡに入射した光は、ほぼすべてｓ偏光光に変換されて出射する。

【００４２】なお、λ／２位相差板３８１を、反射膜３３２の出射面側に選択的に設けるようにすれば、偏光変換素子からほとんどｐ偏光光のみを選択的に出射することができる。

【００４３】無効入射領域ＵＡに入射する光は、従来の技術で説明したように不要な偏光光（本実施例ではｐ偏光光）に変換される。通常は、無効入射領域ＵＡ上に遮光板等を設けて光を遮断するなどしているため、光の利用効率が低下することとなる。特に、図１に示した偏光照明装置５０のような構成においては、光源光軸付近の光量が最も大きくなるため、光軸付近の無効入射領域ＵＡが存在する場合には、光の利用効率の低下が顕著である。本発明は、上述の問題を解決したものであり、次にその詳細を説明する。

【００４４】本実施例では、偏光変換素子アレイ３２０ａの光軸に最も近い偏光変換素子３５０ａ（図１０参照）と、偏光変換素子アレイ３２０ｂ（図１０）の光軸に最も近い偏光変換素子３５０ｂとが、間隔Ｃｐを挟んで左右に反対向きに配置される構成としている。この間隔Ｃｐには、２つの偏光変換素子アレイ３２０ａ，３２０ｂのダミー部３７０と、これらの間の隙間Ｇｐとが存

在する。これにより、光軸付近で集光レンズアレイ３１０に入射した光束のうち、集光レンズアレイ３１０で集光しきれないために偏光分離膜３３１を照射できない光束Ｌ２は、偏光分離膜３３１も反射膜３３２もない間隔Ｃｐを通過し、そのまま出射することになる。この間隔Ｃｐの通過光は、有効な偏光光であるｓ偏光光と無効な偏光光であるｐ偏光光とを含む光束である。そして、この間隔Ｃｐを通過する出射光のうち、必要な偏光光（本実施例ではｓ偏光光）のみを、例えば、この間隔Ｃｐの出射面側に偏光板を設けることにより、有効な光束として利用することが可能である。また、偏光照明装置５０（図１）を、後述する投写型表示装置に適用した場合には、照明領域８０である液晶ライトバルブの入射面に、通常、偏光板が設けられている。従って、このような場合には、別途偏光板を設ける必要がない。

【００４５】偏光変換素子アレイ３２０ａの最外側である透光部３６０は、集光レンズアレイ３１０の最外側のレンズからの光が通過する部分である。この実施例を使用して構成される偏光照明装置５０の光源は、通常、集光レンズアレイ３１０の光の入射面の中心で光の入射面に垂直な中心線上に配置されるため（図４参照）、レンズアレイ３１０の外側、すなわち、この透光部３６０に入射される光は最も光量が小さい。このような状態において、この集光レンズアレイ３１０の最外側からの入射光を偏光変換素子によって変換された偏光光として利用する場合と、変換しないでそのまま利用する場合とでは、第１の光学要素３００（図１）全体で有効に利用できる光量にほとんど差がないことが多い。そこで、偏光変換素子アレイ３２０ａにおける集光レンズアレイ３１０の最外側に対応するこの透光部３６０は、偏光変換素子３５０（図８参照）の構成とせずに透光性部材のみの構成とし、λ／２位相差板３８１も削除している。これにより、集光レンズアレイ３１０の最外側のレンズを通過する光束Ｌ３は、この透光部３６０を通過し、そのまま出射することになる。そして、この透光部３６０から出射する出射光は、上記の間隔Ｃｐを通過して出射する出射光と同様に、有効な偏光光であるｓ偏光光と無効な偏光光であるｐ偏光光とを含む光束である。そして、この透光部３６０を通過する出射光のうち、必要な偏光光（本実施例ではｓ偏光光）のみを、例えば、この透光部３６０の出射面側に偏光板を設けるにより、有効な光束として利用することが可能である。

【００４６】図１１は、図８に示したダミー部３７０およびダミー部３７０の光の入射面側の端部３７２を拡大して示す説明図である。図１１（Ａ）に示すように、ダミー部３７０を有しない偏光変換素子アレイ３２０ａと３２０ｂとが、集光レンズアレイ３１０の光の出射面のレンズ横方向中心ＣＬに対して所定の間隔Ｃｐを設けて配置されているとする。このとき、間隔Ｃｐを通過する光束と、偏光変換素子アレイ３２０ａ，３２０ｂを通過する光束では、光路長が異なることになるが、可能であれば、できる限り光路長を等しくすることが望ましい。また、偏光変換素子アレイ３２０ａ，３２０ｂの端面３７１で反射した光束Ｌex1 は、反射の方向によっては有効に利用できないこともある。また、集光レンズアレイ３１０と、偏光変換素子アレイ３２０ａおよび３２０ｂとは、例えば、図１１（Ａ）に示すように、接着剤３７５によって接着される。このとき、所定の間隔Ｃｐには、接着剤のはみ出し部３７６が発生する。このような接着剤のはみ出し部３７６を通過する光束Ｌex2 は、接着剤表面の不均一性によって乱反射することになり、有効に利用できないことになる。

【００４７】そこで、図１１（Ｂ）に示すように、所定の間隔Ｃｐに偏光変換素子アレイ３２０ａ，３２０ｂを構成する透光性部材３２３と同じ部材でダミー部３７０を設けることとした。こうすれば、上記光路長の問題や、偏光変換素子アレイ３２０ａ，３２０ｂの端面３７１での反射光Ｌex1 の問題を緩和することができる。また、図１１（Ｂ）に示すように、ダミー部３７０を設けるとともに、ダミー部３７０の光の入射面（接着面）側の端部３７２の角を丸くしたり、角をとったりすることにより、接着剤のはみ出しを少なくすることとした。なお、中心部の隙間Ｇｐはなくてもよい。しかし、偏光変換素子アレイ３２０ａと３２０ｂとを集光レンズアレイ３１０の出射面に接着する場合の接着位置の位置合わせ精度を考慮すると、偏光変換素子アレイ３２０ａおよび３２０ｂを集光レンズアレイ３１０の出射面に接着した際に、中心部に若干の隙間Ｇｐができる程度でダミー部３７０を設けることが好ましい。

【００４８】Ｃ．第２実施例：図１２は、第２実施例の光学素子３００’について示す説明図である。

【００４９】図１２の中段には、偏光照明装置５０（図１）のような構成において、レンズアレイ３１０の各レンズＬａ～Ｌｄで集光され偏光変換素子アレイ３２０ａ’の入射面を照射する光の光量分布が示されている。一般に、光軸に最も近いレンズＬａで集光される光の光強度Ｉａが最も強くなり、光軸から遠いレンズで集光される光ほど弱くなり、図１２では、４番目のレンズＬｄで集光される光の光強度Ｉｄが最も弱くなる。また、各レンズＬａ～Ｌｄで集光された光の光量分布は、あるレンズ位置（図１２では３番目のレンズＬｃの位置）を境に、光軸に近いほどレンズ中心に対して光軸寄りの分布になり、光軸から遠いほど光軸の反対寄りの分布になる。図１２では、レンズＬｃで集光された光の光量分布Ｐｃがほぼレンズ中心に分布し、レンズＬｂ、Ｌａと光軸に近いほどその光量分布Ｐｂ、Ｐａと次第に光軸寄りの分布になっている。また、レンズＬｄで集光された光の光量分布Ｐｄが光軸の反対寄りになっている。

【００５０】このような場合に、偏光変換素子アレイの有効入射領域の中心を一律にレンズ中心と一致させる

と、上記のような光量分布のずれに起因する光の損失が発生する。特に、光源光軸付近において、レンズアレイから出射される光の分布と有効入射領域とのずれは、大きな光の損失となる。したがって、レンズアレイ３１０から出射される光の分布に合わせて、すなわち、レンズアレイ３１０から出射される光の分布のピーク間隔に合わせて偏光変換素子アレイ３２０ａ’の各有効入射領域の中心を配列するするようにすることが好ましい。また、レンズアレイ３１０で集光される光をより有効に利用するためには、光軸に近いレンズで集光される光ほどより有効に利用できるようにすることが好ましい。特に、光源光軸付近の光量が大きく、また、光源光軸付近のレンズＬａから出射される光の分布Ｐａがレンズの中心光軸よりも光源光軸側に偏っている場合には、偏光変換素子アレイ３２０ａ’の最も光源光軸側に近い有効入射領域ＥＡ１の中心を光の分布Ｐａのピーク位置にほぼ合わせるようにすることが好ましい。

【００５１】第２実施例は、上記のような、集光レンズアレイのレンズ位置に対する依存性を有する、光強度や光量分布に対応したするものである。第２実施例の光学素子３００’は、基本的には第１実施例と同じ構成であるが、有効入射領域ＥＡ（図中ＥＡ１～ＥＡ４）および無効入射領域ＵＡ（図中ＵＡ１～ＵＡ４）のｘ方向の幅Ｗｐ’が、レンズアレイ３１０の各レンズＬａ～Ｌｄのｘ方向の幅Ｗｌ の１／２よりも大きい偏光変換素子アレイ３２０ａ’，３２０ｂ’を用いている点が異なっている。図１２は、このうち偏光変換素子アレイ３２０ａ’側のみを示している。偏光変換素子アレイ３２０ｂ’側は光軸を基準として偏光変換素子アレイ３２０ａ側と対称であるだけなので、省略した。

【００５２】例えば、３列目のレンズＬｃの中心と、それに対応する有効入射領域ＥＡ３の中心とを等しくするように、偏光変換素子アレイ３２０ａ’を配置する。通常、無効入射領域の幅ＵＡ（図ではＵＡ１からＵＡ４）は、有効入射領域ＥＡの幅Ｗｐ’と等しいので、左側の２つの有効入射領域ＥＡ２，ＥＡ１は各レンズＬｂ，Ｌａの中心に対してしだいに光軸寄りとなる。また、一番右側の有効入射領域ＥＡ４はレンズＬｄの中心に対して光軸の反対寄りとなる。この結果、各有効入射領域ＥＡ１～ＥＡ４が、レンズアレイ３１０から出射される光の光量分布の位置とほぼ一致する。特に、光軸に近い所定の数のレンズ、例えば、２～３個のレンズは、光強度が強いので、これらのレンズで集光される光の光量分布と、それに対応する有効入射領域がほぼ一致することが好ましい。このような構成にすることで、第２実施例は、より光の利用効率を高めることができる。なお、有効入射領域の幅をレンズの幅の１／２に対してどの程度大きくするか、および、どのレンズに対する有効入射領域を基準に配置するかは、レンズアレイの数や、各レンズに対応する光量分布の関係から実験的に容易に求められる。また、有効入射領域や無効入射領域の幅は、レンズの幅の１／２より大きくすることに限定する必要はなく、偏光変換素子アレイの光の入射面を照射する実際の光量分布によって決定される。

【００５３】Ｄ．投写型表示装置

図１３は、図１に示す偏光照明装置５０を備えた投写型表示装置８００の要部を示す概略構成図である。この投写型表示装置８００は、偏光照明装置５０と、ダイクロイックミラー８０１，８０４と、反射ミラー８０２，８０７，８０９と、リレーレンズ８０６，８０８，８１０と、３枚の液晶ライトバルブ８０３，８０５，８１１と、クロスダイクロイックプリズム８１３と、投写レンズ８１４とを備えている。

【００５４】ダイクロイックミラー８０１，８０４は、白色光束を赤、青、緑の３色の色光に分離する色光分離手段としての機能を有する。３枚の液晶ライトバルブ８０３，８０５，８１１は、与えられた画像情報（画像信号）に従って、３色の色光をそれぞれ変調して画像を形成する光変調手段としての機能を有する。クロスダイクロイックプリズム８１３は、３色の色光を合成してカラー画像を形成する色光合成手段としての機能を有する。投写レンズ８１４は、合成されたカラー画像を表す光をスクリーン８１５上に投写する投写光学系としての機能を有する。

【００５５】青光緑光反射ダイクロイックミラー８０１は、偏光照明装置５０から出射された白色光束の赤色光成分を透過させるとともに、青色光成分と緑色光成分とを反射する。透過した赤色光は、反射ミラー８０２で反射されて、赤光用液晶ライトバルブ８０３に達する。一方、第１のダイクロイックミラー８０１で反射された青色光と緑色光のうちで、緑色光は緑光反射ダイクロイックミラー８０４によって反射され、緑光用液晶ライトバルブ８０５に達する。一方、青色光は、第２のダイクロイックミラー８０４も透過する。

【００５６】この実施例では、青色光の光路長が３つの色光のうちで最も長くなる。そこで、青色光に対しては、ダイクロイックミラー８０４の後に、入射レンズ８０６と、リレーレンズ８０８と、出射レンズ８１０とを含むリレーレンズ系で構成された導光手段８５０が設けられている。すなわち、青色光は、緑光反射ダイクロイックミラー８０４を透過した後に、まず、入射レンズ８０６及び反射ミラー８０７を経て、リレーレンズ８０８に導かれる。さらに、反射ミラー８０９によって反射されて出射レンズ８１０に導かれ、青光用液晶ライトバルブ８１１に達する。なお、３枚の液晶ライトバルブ８０３，８０５，８１１は、図７における照明領域８０に相当する。

【００５７】３つの液晶ライトバルブ８０３、８０５、８１１は、図示しない外部の制御回路から与えられた画像信号（画像情報）に従って、それぞれの色光を変調

し、それぞれの色成分の画像情報を含む色光を生成する。変調された3つの色光は、クロスダイクロイックプリズム813に入射する。クロスダイクロイックプリズム813には、赤光を反射する誘電体多層膜と、青光を反射する誘電体多層膜とが十字状に形成されている。これらの誘電体多層膜によって3つの色光が合成されて、カラー映像を表す光が形成される。合成された光は、投写光学系である投写レンズ814によってスクリーン815上に投写され、映像が拡大されて表示される。

【0058】この投写型表示装置800では、光変調手段として、特定の偏光方向の光束（s偏光光またはp偏光光）を変調するタイプの液晶ライトバルブ803，805，811が用いられている。これらの液晶ライトバルブには、入射側と出射側にそれぞれ偏光板（図示せず）が貼り付けられているのが普通である。従って、所定の偏光方向、例えばs偏光光のみが変調されてクロスダイクロイックプリズム813に入射する。このとき、光学素子300に入射された光束のうち、集光レンズアレイ310で集光されて偏光分離膜331を照射した光束は、前述した図5にも示したように、すべてs偏光光に変換されて出射される。光学素子300から出射された光束は、出射側レンズ390によって液晶ライトバルブ803，805，811を照明する。

【0059】また、光学素子300に入射された光束のうち、集光レンズアレイ310で集光しきれずに、反射膜332を照射した光束は、従来の技術で説明したようにp偏光光に変換されて出射され、液晶ライトバルブ803，805，811を照明する。しかし、上述したように、液晶ライトバルブ803，805，811の入射面には、上述したように、s偏光光のみを利用するべく偏光板が設けられており、p偏光光は遮断される。一方、本発明の実施例による光学素子300における間隔Cp（図10）を通過した光束は、偏光光に変換されることなく出射されて、液晶ライトバルブ803，805，811を照明する。この照明光は、液晶ライトバルブ803，805，811で利用可能なs偏光光成分を含む白色光であるため、液晶ライトバルブ803，805，811に照射した光のうちのs偏光光成分のみを利用することが可能である。従って、図13に示す投写型表示装置800は、実施例による光学素子300を用いた偏光照明装置50を使用しているので、従来よりも光の利用効率が高いという利点を有している。

【0060】以上のように、この実施例による光学素子を用いることによって、投写型表示装置における光の利用効率を従来に比べて高めることができる。従って、スクリーン815上に投写される映像をより明るくすることができる。

【0061】なお、この発明は上記の実施例や実施形態に限られるものではなく、その要旨を逸脱しない範囲において種々の態様において実施することが可能であり、例えば次のような変形も可能である。

【0062】本発明による偏光照明装置は、図13に示す投写型表示装置に限らず、これ以外の種々の装置に適用することが可能である。例えば、カラー画像でなく、白黒画像を投写する投写型表示装置にも本発明による偏光ビームスプリッタアレイを適用することができる。この場合には、図13の装置において、液晶ライトバルブが1枚で済み、また、光束を3色に分離する色光分離手段と、3色の光束を合成する色光合成手段とを省略できる。さらに、ライトバルブを1つしか用いない投写型カラー表示装置にも本発明を適用することができる。また、反射型のライトバルブを用いる投写型表示装置やリア型表示装置等の偏光照明光を利用する画像表示装置にも適用可能である。

【図面の簡単な説明】

【図1】本発明の実施例を適用する偏光照明装置50の要部を平面的にみた概略構成図。

【図2】第1の光学要素200の斜視図。

【図3】偏光変換素子アレイ320b（320a）の基本動作を示す説明図である。

【図4】第1実施例である光学素子300の光の入射面を示す正面図。

【図5】第1実施例である光学素子300の光の出射面を示す背面図。

【図6】図5のA－A’断面図。

【図7】第1実施例である光学素子300の側面図。

【図8】偏光変換素子アレイ320a，320bの構成を示す斜視図。

【図9】偏光ビームスプリッタアレイ340の製造例を示す説明図。

【図10】図5に示すA－A’断面の一部拡大図。

【図11】図8に示したダミー部370およびダミー部370の光の入射面側の端部372を拡大して示す説明図。

【図12】第2実施例の光学素子300’について示す説明図。

【図13】図1に示す偏光照明装置50を備えた投写型表示装置800の要部を示す概略構成図。

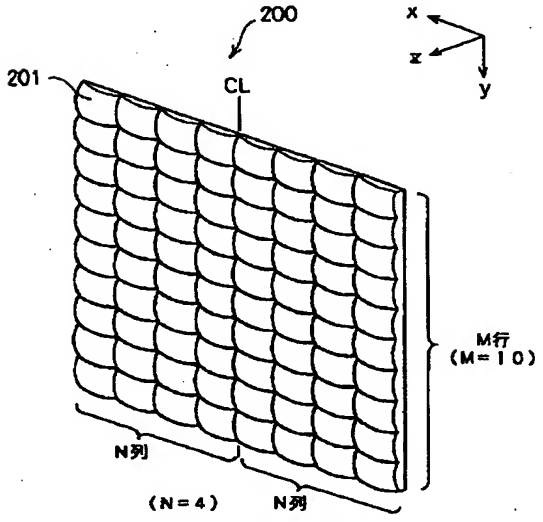
【図14】従来の光学素子の平面図。

【符号の説明】

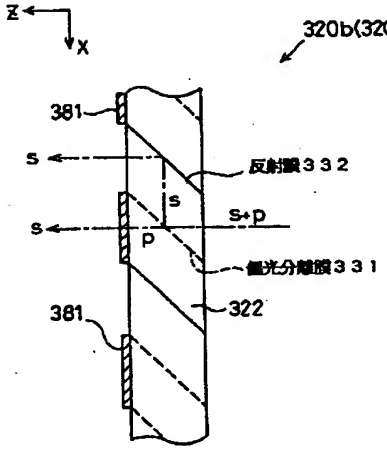
10…レンズアレイ
20…偏光ビームスプリッタアレイ
30…偏光ビームスプリッタ
36…偏光分離膜
40…プリズム
46…反射膜
50…偏光照明装置
60…光源部
70…偏光発生装置
80…照明領域

９０…照明領域
１０１…光源ランプ
１０２…放物面リフレクター
２００…第１の光学要素
２０１…光束分割レンズ
２０２…中間光束
３００…光学素子
３１０…集光レンズアレイ
３１１…集光レンズ
３１１ｃ…中心
３２０ａ，３２０ｂ…偏光変換素子アレイ
３２１，３２２，３２２ｂ，３２２ｃ…透光性部材
３２３…透光性部材（板ガラス）
３２５…接着剤
３３１…偏光分離膜
３３２…反射膜
３４０…偏光ビームスプリッタ
３４０…偏光ビームスプリッタアレイ
３５０…偏光変換素子
３５０ａ…偏光変換素子
３５０ｂ…偏光変換素子
３６０…透光部
３７０…ダミー部
３７１…端面
３７２…端部
３７５…接着剤
３７６…接着剤のはみ出し部
３８１…λ／２位相差板
３９０…出射側レンズ
４００…第２の光学要素
８００…投写型表示装置
８０１，８０４…ダイクロイックミラー
８０２，８０７，８０９…反射ミラー
８０３，８０５，８１１…液晶ライトバルブ
８０６…入射レンズ
８０７…反射ミラー
８０８…リレーレンズ
８０９…反射ミラー
８１０…出射レンズ
８１３…クロスダイクロイックプリズム
８１４…投写レンズ
８１５…スクリーン
８５０…導光手段
ＣＬ…レンズ横方向中心
Ｃｐ…間隔
ＥＡ…有効入射領域
ＥＡ１，ＥＡ２，ＥＡ３，ＥＡ４…有効入射領域
Ｇｐ…隙間
Ｉａ，Ｉｂ，Ｉｃ，Ｉｄ…光強度
Lex1…光束
Lex2…光束
Ｌ１…光束
Ｌ２…光束
Ｌ３…光束
Ｌａ，Ｌｂ，Ｌｃ，Ｌｄ…レンズ
Ｐｂ，Ｐｂ，Ｐｃ，Ｐｄ…光量分布
ＵＡ…無効入射領域
ＵＡ１，ＵＡ２，ＵＡ３，ＵＡ４…無効入射領域

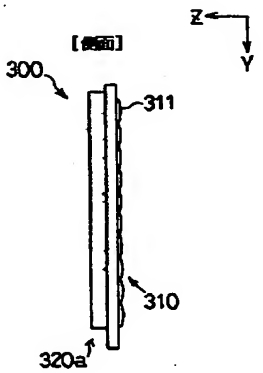
【図２】



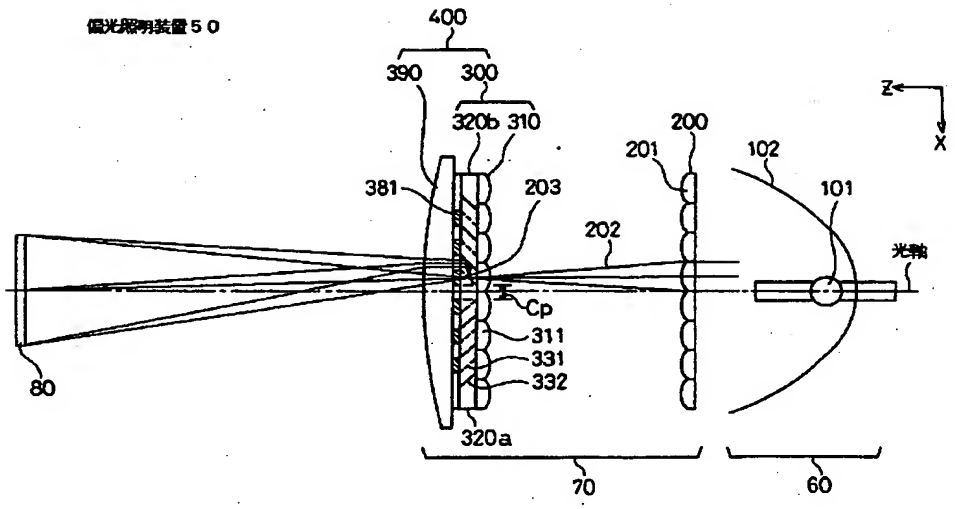
【図３】



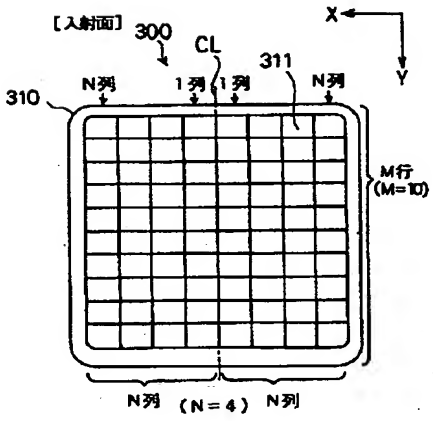
【図７】



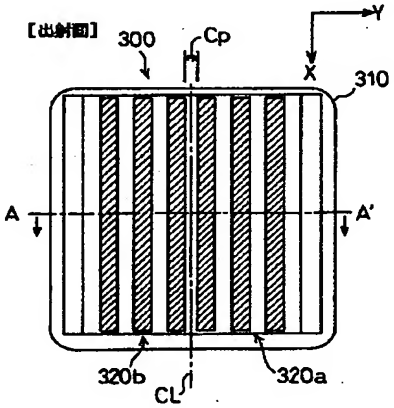
【図１】


偏光照明装置５０
400
390
300
320b
310
200
201
102
381
203
101
202
光軸
Cp
311
331
332
80
320a
70
60
Z
X

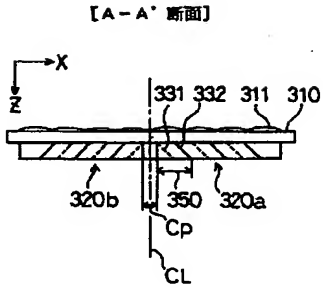
【図４】


［入射面］
300
CL
311
X
Y
310
N列
1列
1列
N列
M行
(M=10)
N列
(N=4)
N列

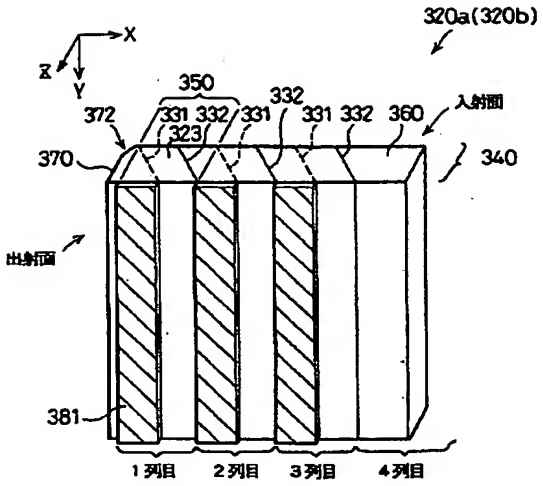
【図５】


［出射面］
300
Cp
Y
X
310
A
A'
320b
CL
320a

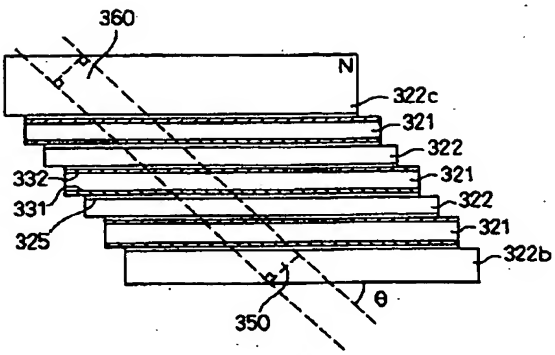
【図６】


［A－A' 断面］
X
Z
331
332
311
310
320b
350
320a
Cp
CL

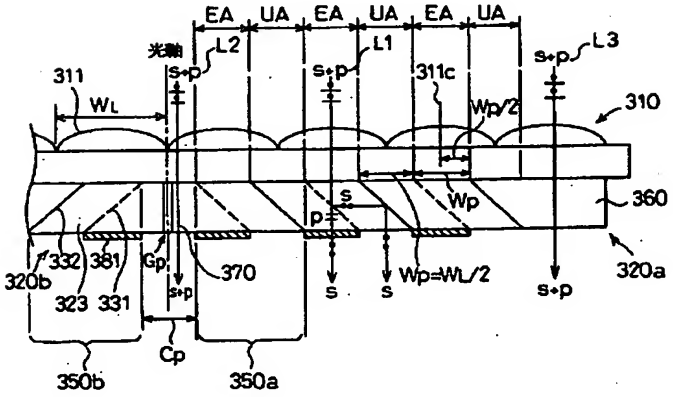
【図８】


320a(320b)
X
Z
Y
350
372
331 332 331 332 360
323
332
入射面
370
340
出射面
381
1列目
2列目
3列目
4列目

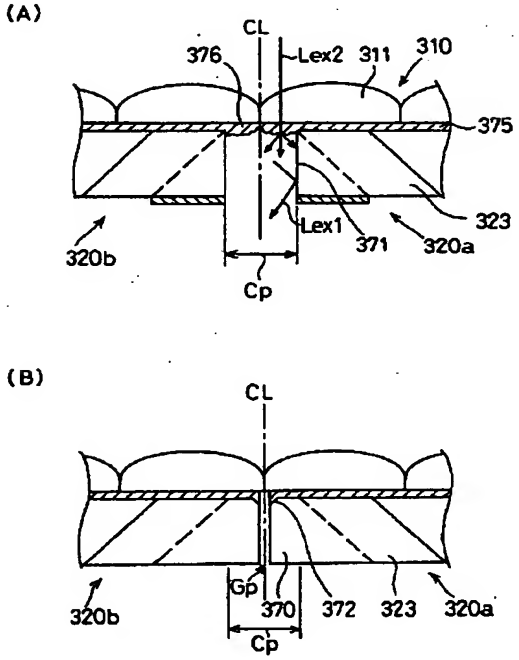
【図９】


360
N
322c
321
322
332
321
331
322
325
321
322b
θ
350

【図１０】


EA
UA
EA
UA
EA
UA
光軸
L2
L1
L3
s+p
311
311c
WL
Wp/2
310
Wp
360
s
p
320b
332
381
Gp
370
323
331
s+p
Wp=WL/2
320a
Cp
350b
350a

【図１１】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CL
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Lex2
311
310
375
323
Lex1
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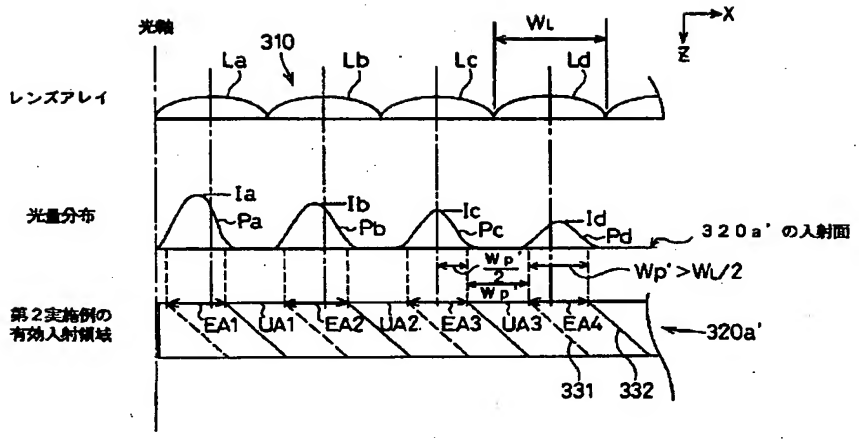
320b
Cp
(B)
CL
Gp
370
372
323
320a
320b
Cp

【図12】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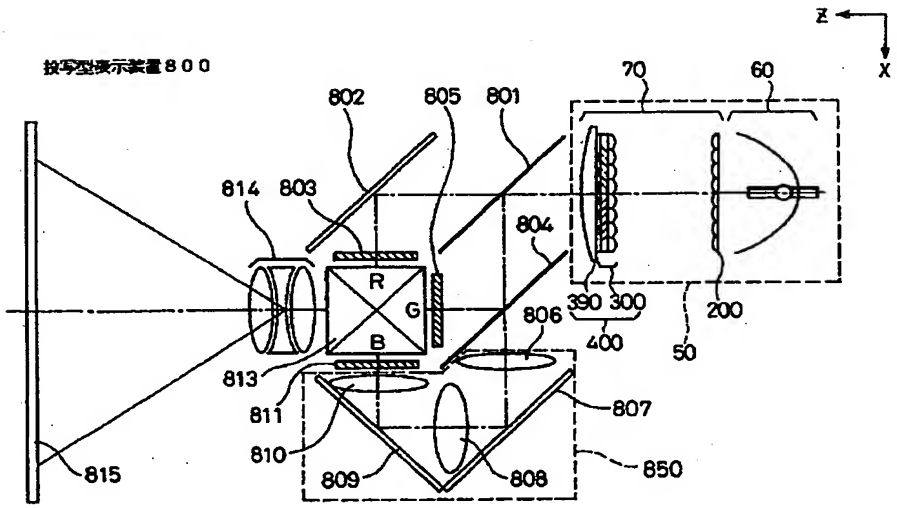
Lb
Lc
Ld
WL
X
Z
レンズアレイ
光量分布
Ia
Pa
Ib
Pb
Ic
Pc
Id
Pd
320a' の入射面
Wp'/2
Wp
Wp'>WL/2
第2実施例の
有効入射領域
EA1
UA1
EA2
UA2
EA3
UA3
EA4
320a'
331
332

【図13】


Z
X
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805
801
814
803
804
R
G
B
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806
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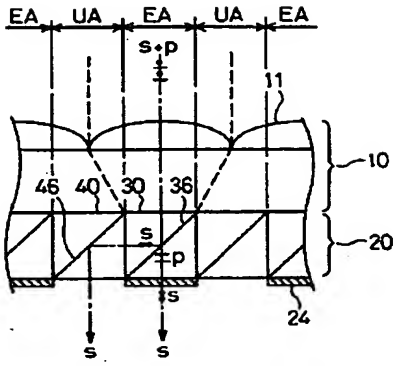
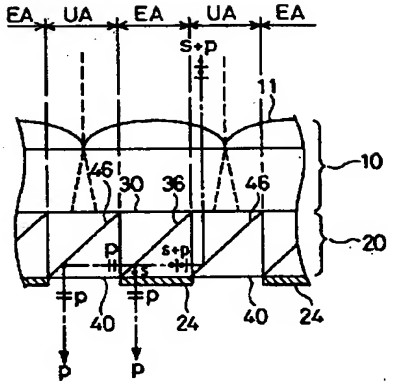
811
807
810
809
808
850
815

【図14】

(A)


EA
UA
EA
UA
EA
S+P
11
10
46
40
30
36
S
P
20
S
24
S
S

(B)


EA
UA
EA
UA
EA
S+P
11
10
46
30
36
46
P
S+P
20
P
P
40
24
40
24
P
P

* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Said polarization separation side and said reflector are an optical element which two or more arrays are carried out by turns through a translucency member, and is characterized by being arranged and said two polarization sensing-element arrays becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[Claim 2] The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 1.
[Claim 3] The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claims 1 or 2.
[Claim 4] It is fixed to one field of the lens array by which two or more lenses have been arranged in the shape of a matrix, and said lens array. It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Said polarization separation side and said reflector are an optical element which two or more arrays are carried out by turns through a translucency member, and is characterized by being arranged and said two polarization sensing-element arrays becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[Claim 5] The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 4.
[Claim 6] The optical element characterized by removing the corner by the side of said predetermined spacing of said dummy area in claim 5.
[Claim 7] The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 4 thru/or either of 6.
[Claim 8] The optical element to which the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector is characterized by being larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector in claim 4 thru/or either of 7.
[Claim 9] It has the light source section and the optical element which changes and carries out outgoing radiation of the light from said light source section to one kind of polarization light. Said optical element It is fixed to one field of the lens array by which two or more lenses have been arranged in the shape of a matrix, and said lens array. It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation

side. Said polarization separation side and said reflector are a polarization lighting system which two or more arrays are carried out by turns through a translucency member, and is characterized by being arranged and said two polarization sensing-element arrays becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.

[Claim 10] The polarization lighting system characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 9.

[Claim 11] The polarization lighting system characterized by removing the corner by the side of said predetermined spacing of said dummy area in claim 10.

[Claim 12] The polarization lighting system characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 9 thru/or either of 11.

[Claim 13] The polarization lighting system characterized by arranging said polarization separation side in claim 9 thru/or either of 12 according to the distribution of light by which outgoing radiation is carried out from said lens array.

[Claim 14] It is the polarization lighting system characterized by to arrange a polarization separation side in the location nearest to said predetermined said two spacing side of a polarization sensing-element array, and to arrange the core of this polarization separation side among two or more lenses of said lens array in claim 9 thru/or either of 13 at said predetermined spacing side rather than said polarization separation side and the medial axis of the lens arranged in the nearest location.

[Claim 15] The polarization lighting system with which the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector is characterized by being larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector in claim 9 thru/or either of 14.

[Claim 16] A polarization lighting system and a modulation means to become irregular based on the picture signal which was able to give the outgoing radiation light from said polarization lighting system, It has the projection optical means which projects the flux of light modulated by said modulation means. Said polarization lighting system It has the light source section and the optical element which changes and carries out outgoing radiation of the incident light which carries out incidence to the light of the predetermined polarization direction from said light source section. Said optical element It is fixed to one field of the lens array by which two or more lenses have been arranged in the shape of a matrix, and said lens array. It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Said polarization separation side and said reflector are a projection mold display which two or more arrays are carried out by turns through a translucency member, and is characterized by being arranged and said two polarization sensing-element arrays becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.

[Claim 17] The projection mold display characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 16.

[Claim 18] The projection mold display characterized by removing the corner by the side of said predetermined spacing of said dummy area in claim 17.

[Claim 19] The projection mold display characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member in claim 16 thru/or either of 18.

[Claim 20] The projection mold display characterized by arranging said polarization separation side in claim 16 thru/or either of 19 according to the distribution of light by which outgoing radiation is carried out from said lens array.

[Claim 21] It is the projection mold display characterized by to arrange a polarization separation side in the location nearest to said predetermined said two spacing side of a polarization sensing-element array, and to arrange the core of this polarization separation side among two or more lenses of said lens array in claim 16 thru/or either of 20 at said predetermined spacing side rather than said polarization separation side and the medial axis of the lens arranged in the nearest location.

[Claim 22] The projection mold display with which the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector is characterized by being

larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector in claim 16 thru/or either of 21.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a polarization lighting system and a projection mold display equipped with the optical element which changes into the predetermined polarization flux of light the light by which incidence was carried out, and such an optical element.
[0002]
[Description of the Prior Art] In order to raise the use effectiveness of light and to obtain a bright display, the approach of changing and using the light which has the random polarization direction for the light which has the polarization direction of an one direction is used for the illumination-light study system of a projection mold display. What was indicated by JP,7-294906,A is known as an optical element (polarization sensing element) which changes the light which has such a random polarization direction into the light which has the polarization direction of an one direction. Drawing 14 is the top view of such an optical element. This optical element is equipped with the polarization beam splitter array 20 which stuck by turns the linear polarization beam splitter 30 which has the polarization demarcation membrane 36, and the linear prism 40 which has the reflective film 46. Moreover, the plane of incidence of the light of the polarization beam splitter array 20 is equipped with the lens array 10 which consists of two or more condenser lenses, and lambda / 2 phase-contrast plate 24 is alternatively formed in a part of outgoing radiation side of light.
[0003] As shown in drawing 14 (A), it is condensed by the lens array 10, the flux of light by which incidence was carried out to the lens array 10 is changed into two or more division flux of lights (middle flux of light), and incidence is carried out as incident light which contains an s-polarized light component and a p-polarized light component in the polarization beam splitter 30 arranged corresponding to the lens array 10. This incident light is first separated into s-polarized light light and p-polarized light light by the polarization demarcation membrane 36. It is reflected almost perpendicularly by the polarization demarcation membrane 36 which makes 45 degrees to optical plane of incidence, and it is reflected still more perpendicularly by the reflective film 46 which makes 45 degrees to optical plane of incidence, and outgoing radiation of the s-polarized light light is carried out from prism 40 with it. On the other hand, p-polarized light light penetrates the polarization demarcation membrane 36 as it is, and outgoing radiation is changed and carried out to s-polarized light light with lambda / 2 phase-contrast plate 24. Therefore, this optical element is a component which changes and carries out outgoing radiation of all the flux of lights that have the random polarization direction which carried out incidence to the s-polarized light flux of light.
[0004]
[Problem(s) to be Solved by the Invention] As for the flux of light by which incidence was carried out to the lens array 10, it is ideal that it is condensed with each condenser lens which constitutes the lens array 10, and all the flux of lights carry out incidence to the polarization beam splitter corresponding to each condenser lens. However, as shown in drawing 14 (B), the flux of light which carries out incidence to prism 40, without being condensed completely exists in the flux of light by which incidence was carried out to the actual lens array 10. Incidence of such the flux of light that carried out incidence to prism 40 is carried out to the polarization beam splitter 30 which carried out total reflection by the reflective film 46, and has been arranged next. And the flux of light which carried out incidence to the polarization beam splitter 30 is separated into s-polarized light light and p-polarized light light by the polarization demarcation membrane 36. It reflects by the polarization demarcation membrane 36, and the separated s-polarized light light is changed into p-polarized light light by lambda / 2 phase-contrast plate 24, and carries out outgoing radiation with it. Moreover, outgoing radiation of the p-polarized light light is reflected and carried out by the reflective film 46 of the prism 40 which penetrated the polarization demarcation membrane 36 and has been arranged in the transparency direction. Therefore, outgoing radiation of the flux of light which carried out incidence to this optical element will be

changed and carried out to the flux of light also including not the single flux of light but the p-polarized light flux of light of s-polarized light light. Here, the incidence field of a polarization sensing element is divided into the effective incidence field EA and the invalid incidence field UA. The incidence field of the polarization sensing element by which the effective incidence field EA is changed into the polarization light of a request of the flux of light by which incidence was carried out, and outgoing radiation is carried out is said. Moreover, the incidence field of the polarization sensing element by which the invalid incidence field UA is changed into the polarization light whose flux of light by which incidence was carried out is not a request, and outgoing radiation is carried out is said. Therefore, in this conventional example, the plane of incidence of two or more polarization beam splitters 30 is the effective incidence field EA, and the plane of incidence of two or more prism 40 serves as the invalid incidence field UA.

[0005] When to use only one kind of polarization light is desired, the light by which incidence is carried out to such an invalid incidence field UA must be cut with a polarizing plate etc. That is, in such a case, since the outgoing radiation light of an above-mentioned p-polarized light light was not used, the technical problem that the use effectiveness of light will fall occurred.

[0006] This invention is made in order to solve the above-mentioned technical problem in the conventional technique, and it aims at offering the technique which raises the use effectiveness of the light of the optical element used with a polarization lighting system or a projection mold display.

[0007]

[The means for solving a technical problem, and its operation and effectiveness] In order to solve an above-mentioned technical problem, the 1st invention is an optical element and it has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. The polarization separation side where each of said polarization sensing-element array divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member, and said two polarization sensing-element arrays are characterized by being arranged and becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.

[0008] The plane of incidence of the light of a polarization sensing-element array is divided into the 1st field as for which incident light carries out direct incidence to a polarization demarcation membrane side, and the 2nd field which carries out direct incidence to a reflector. Among these, although the light which carried out incidence to the 1st incidence field is changed into one kind of predetermined polarization light (effective polarization light), the light which carried out incidence to the 2nd incidence field is changed into a different invalid polarization light from it. According to the configuration of invention of the above 1st, since incidence is not carried out to the 2nd field, outgoing radiation of the light which passes predetermined spacing is carried out from an optical element with a random polarization light, without being changed into an invalid polarization light. Therefore, since an effective polarization light contained in a random polarization light which passes such predetermined spacing can also be used, the use effectiveness of the light of an optical element can be raised.

[0009] It is desirable to form the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member here.

[0010] If it does in this way, the optical path length of the flux of light which passes a polarization sensing-element array, and the flux of light which passes predetermined spacing can be brought close. Moreover, the flux of light reflected by the end face by the side of predetermined spacing among each both ends of two polarization sensing-element arrays cannot irradiate an exposure side effectively depending on the direction of reflective, and may be unable to use light effectively. This problem can be eased if it is made a configuration as mentioned above.

[0011] Moreover, the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays may be formed by the translucency member.

[0012] Generally, the core is set up in spacing in the middle of [which has been arranged] two sensing-element arrays (i.e., predetermined), and on the optical axis of the light source, the optical element of the 1st invention makes the core in agreement, and is used. On the other hand, generally, even if it changes into one kind of predetermined polarization light the light by which incidence is carried out to the edge of the side which is not a predetermined spacing side of two polarization sensing-element arrays, it is almost ineffective [light / the outgoing radiation light of the light source is in the inclination which becomes so weak that it separates from the optical axis of the light source, and] on the use effectiveness of light. Therefore, if it is made the above configurations, since a polarization separation side and a

reflector can be reduced, a cheap optical element is realizable.
[0013] The lens array by which the 2nd invention is an optical element and two or more lenses have been arranged in the shape of a matrix, It is fixed to one field of said lens array, and has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member, and said two polarization sensing-element arrays are characterized by being arranged and becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[0014] Also in the 2nd invention, the plane of incidence of the light of a polarization sensing-element array is divided into the 1st field as for which incident light carries out direct incidence to a polarization demarcation membrane side, and the 2nd field which carries out direct incidence to a reflector like the 1st above-mentioned invention. Although it is desirable that incidence is carried out to the 1st field as for all the flux of lights condensed by the lens array, the flux of light by which incidence is carried out to the 2nd field also exists. According to the configuration of invention of the above 2nd, since incidence is not carried out to the 2nd field, outgoing radiation of the flux of light which passes predetermined spacing, without carrying out incidence to a polarization sensing-element array among the flux of lights which carried out outgoing radiation from the lens array is carried out from an optical element with a random polarization light, without being changed into an invalid polarization light. Therefore, since an effective polarization light contained in a random polarization light which passes such predetermined spacing can also be used, the use effectiveness of the light of an optical element can be raised.
[0015] It is desirable that the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector is larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector here.
[0016] Since according to the above-mentioned configuration a polarization sensing-element array can be constituted so that the flux of light which carried out outgoing radiation from the lens array may carry out incidence more efficiently, the use effectiveness of the light of an optical element can be raised.
[0017] The 3rd invention is a polarization lighting system and it has the light source section and the optical element which changes and carries out outgoing radiation of the light from said light source section to one kind of polarization light. Said optical element It is fixed to one field of the lens array by which two or more lenses have been arranged in the shape of a matrix, and said lens array. It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member, and said two polarization sensing-element arrays are characterized by being arranged and becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[0018] According to the 3rd invention, since the optical element with the high use effectiveness of light is used, the use effectiveness of the light of a lighting system can be raised.
[0019] Moreover, it is desirable to arrange said polarization separation side according to the distribution of light by which outgoing radiation is carried out from said lens array.
[0020] If it does in this way, since the light by which outgoing radiation is carried out from a lens array can be used effectively, the use effectiveness of the light of a lighting system can be raised further.
[0021] Furthermore, a polarization separation side is arranged in the location nearest to said predetermined said two spacing side of a polarization sensing-element array, and, as for the core of this polarization separation side, being arranged at said predetermined spacing side is more desirable than said polarization separation side and the medial axis of the lens arranged in the nearest location among two or more lenses of said lens array.
[0022] The outgoing radiation light of the light source has much quantity of light near the optical axis of the light source. Moreover, the quantity of light distribution of light by which outgoing radiation is carried out from near a light source optical axis inclines toward the light source optical-axis side rather than the medial axis of the lens arranged in the polarization separation side arranged in the location nearest to the predetermined two spacing side of a polarization sensing-element array, and the nearest location. Therefore, according to the above configurations, since the light near [this] a light source optical axis can be used effectively, the use effectiveness of the light of a lighting system can be

raised further.
[0023] A modulation means for the 4th invention to be a projection mold display and to become irregular based on the picture signal which was able to give the outgoing radiation light from a polarization lighting system and said polarization lighting system, It has the projection optical means which projects the flux of light modulated by said modulation means. Said polarization lighting system It has the light source section and the optical element which changes and carries out outgoing radiation of the incident light which carries out incidence to the light of the predetermined polarization direction from said light source section. Said optical element It is fixed to one field of the lens array by which two or more lenses have been arranged in the shape of a matrix, and said lens array. It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member, and said two polarization sensing-element arrays are characterized by being arranged and becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[0024] According to the 4th invention, since the lighting system using an optical element with the high use effectiveness of light is used, the image projected on a projection side can be made bright.
[0025]
[Embodiment of the Invention] Next, the gestalt of operation of this invention is explained based on an example.
[0026] A. Polarization lighting system : drawing 1 is the outline block diagram which saw superficially the important section of the polarization lighting system 50 which applies the example of this invention. This polarization lighting system 50 is equipped with the light source section 60 and the polarization generator 70. The light source section 60 carries out outgoing radiation of the flux of light of the random polarization direction containing an s-polarized light component and a p-polarized light component. The polarization direction is changed into one kind of linearly polarized light light (for example, s-polarized light light) which gathered mostly by the polarization generator 70, and the flux of light by which outgoing radiation was carried out from the light source section 60 illuminates the lighting field 80 with it.
[0027] The light source section 60 is equipped with the light source lamp 101 and the paraboloid reflector 102. the light emitted from the light source lamp 101 is reflected in an one direction with the paraboloid reflector 102 -- having -- abbreviation -- it becomes the parallel flux of light and incidence is carried out to the polarization generator 70.
[0028] The polarization generator 70 is equipped with the 1st optical element 200 and the 2nd optical element 400. Drawing 2 is the perspective view of the 1st optical element 200. The 1st optical element 200 has the configuration with which the minute flux of light division lens 201 which has a rectangle-like profile was arranged by M lines in the lengthwise direction, and was arranged in the shape of [of 2N train] a matrix in the longitudinal direction. Therefore, from the lens longitudinal direction core CL, N train existence is recognized leftward N train and rightward. In this example, it is M= 10 and N= 4. The 1st optical element 200 is arranged so that an optical axis may be in agreement with the core of the 1st optical element 200. The appearance configuration where each flux of light division lens 201 was seen from the Z direction is set up so that the configuration and analog of the lighting field 80 may be made. In this example, since the oblong long lighting field 80 is assumed in the x directions, the appearance configuration on XY flat surface of the flux of light division lens 201 is also oblong.
[0029] The 2nd optical element 400 of drawing 1 is equipped with the optical element 300 and the outgoing radiation side lens 390. And the optical element 300 and the outgoing radiation side lens 390 are arranged so that the core may be in agreement with an optical axis.
[0030] The optical element 300 is equipped with the condenser lens array 310 and two polarization sensing-element arrays 320a and 320b. The condenser lens array 310 is a lens array of the same configuration as the 1st optical element 200, and is arranged at the sense which faces. The condenser lens array 310 has the role which condenses two or more division flux of lights divided with each flux of light division lens 201 with the 1st optical element 200. The polarization sensing-element arrays 320a and 320b have the role which changes and carries out outgoing radiation of the flux of light by which incidence was carried out to one kind of linearly polarized light light (for example, s-polarized light light and p-polarized light light). Drawing 3 is the explanatory view showing basic actuation of polarization sensing-element array 320b (320a). The incident light which has the random polarization direction which contains an s-polarized light component and a p-polarized light component in the plane of incidence of a polarization sensing element carries out incidence. This incident light is first separated into s-polarized light light and p-polarized light light by the polarization

demarcation membrane 331. After it is reflected almost perpendicularly by the polarization demarcation membrane 331 and being reflected still more perpendicularly by the reflective film 332, outgoing radiation of the s-polarized light light is carried out. On the other hand, p-polarized light light penetrates the polarization demarcation membrane 331 as it is. lambda / 2 phase-contrast plate 381 is arranged, and this p-polarized light light is changed into s-polarized light light, and carries out outgoing radiation to the outgoing radiation side of the p-polarized light light which penetrated the polarization demarcation membrane. Therefore, the most serves as s-polarized light light, and outgoing radiation of the light which passed the polarization sensing element is carried out. Moreover, the s-polarized light light reflected by the reflective film 332 should just arrange lambda / 2 phase-contrast plate 381 to the outgoing radiation side which carries out outgoing radiation to make into p-polarized light light light by which outgoing radiation is carried out from a polarization sensing element. In addition, this invention has the description in an optical element 300, and, for details, mentions it later.

[0031] The outgoing radiation side lens 390 of drawing 1 has the role superimposed so that two or more division flux of lights (division flux of light of the linearly polarized light light changed by the polarization sensing-element arrays 320a and 320b) of all by which outgoing radiation is carried out from an optical element 300 may irradiate the lighting field 80.

[0032] The flux of light which outgoing radiation was carried out from the light source section 60, and carried out incidence to the 1st optical element 200 is divided into the middle flux of light 202 by each flux of light division lens 201. The middle flux of light 202 is converged in a flat surface perpendicular to an optical axis (drawing 1 XY flat surface) according to a condensing operation of the flux of light division lens 201 and a condenser lens 311. The light source image of the number of the flux of light division lenses 201 and the same number is formed in the location which the middle flux of light 202 converges. In addition, the location in which a light source image is formed is near the polarization demarcation membrane 331 (refer to drawing 3) in polarization sensing-element array 320a and 320b.

[0033] Outgoing radiation of the flux of light which was condensed by the condenser lens array 310 among the flux of lights by which incidence was carried out to the optical element 300, and irradiated the polarization demarcation membrane 331 is changed and carried out to one kind of linearly polarized light light. The flux of light by which outgoing radiation was carried out from the optical element 300 illuminates the lighting field 80 with the outgoing radiation side lens 390. Since the lighting field 80 is illuminated by the flux of light of a large number divided with many flux of light division lenses 201, it can illuminate the whole lighting field 80 uniformly.

[0034] B. The 1st example : the front view showing the plane of incidence of the light of the optical element 300 whose drawing 4 is the 1st example, the rear view in which drawing 5 shows an outgoing radiation side, and drawing 6 show the A-A' sectional view of drawing 5 , and drawing 7 shows the side elevation.

[0035] As for this optical element 300, two polarization sensing-element arrays 320a and 320b are stuck on the flat optical outgoing radiation side of the condenser lens array 310 with optical adhesives. Two polarization sensing-element arrays 320a and 320b are arranged on both sides of the predetermined spacing Cp at the opposite sense at right and left on the basis of the longitudinal direction core CL of the condenser lens array 310. About this predetermined spacing Cp, it mentions later. As for the condenser lens array 310, the condenser lens 311 which has an abbreviation rectangle-like profile like the 1st optical element 200 (drawing 2) has the configuration with which it was arranged in the shape of [of 2N train] a matrix in M lines and the direction of width in the longitudinal direction. Therefore, from the core CL of a lens longitudinal direction, N train existence is recognized leftward N train and rightward. In this example, it is M= 10 and N= 4.

[0036] Drawing 8 is the perspective view showing the configuration of the polarization sensing-element arrays 320a and 320b. These polarization sensing-element arrays 320a and 320b equip a part of optical outgoing radiation side of the polarization beam splitter array 340 and the polarization beam splitter array 340 with lambda / 2 phase-contrast plate 381 (the slash in drawing shows) arranged alternatively. As for the polarization beam splitter array 340, the cross section has the configuration on which two or more translucency members 323 of the shape of a column of a parallelogram were stuck one by one, respectively. The polarization demarcation membrane 331 and the reflective film 332 are formed in the interface of the translucency member 323 by turns. lambda / 2 phase-contrast plate 381 is arranged alternatively at a part for the mapping division of the x directions of the outgoing radiation side of the light of the polarization demarcation membrane 331 or the reflective film 332. In this example, selecting arrangement of lambda / the 2 phase-contrast plate 381 is carried out to a part for the mapping division of the x directions of the outgoing radiation side of the light of the polarization demarcation membrane 331.

[0037] As previously explained using drawing 3 , the incident light by which incidence was carried out to the polarization demarcation membrane 331 penetrates the polarization demarcation membrane 331, and is divided into the linearly polarized light light which it is changed into a predetermined linearly polarized light light by lambda / 2 phase-

contrast plate 381, and carries out outgoing radiation, and a predetermined linearly polarized light light which reflects by the polarization demarcation membrane 331, and reflects and carries out outgoing radiation by the reflective film 332. Therefore, it can be considered including one adjacent polarization demarcation membrane 331 and one adjacent reflective film 332 that one block which consists of one more lambda / a 2 phase-contrast plate 381 is one polarization sensing element 350. As for the polarization sensing-element arrays 320a and 320b, two or more trains array of such a polarization sensing element 350 is carried out in the x directions. Since several Ns of the direction of a train of one side of the condenser lens array 310 are 4, the polarization sensing element 350 of four trains is constituted in principle from this example by one side. However, the part 360 equivalent to the polarization sensing element of eye four trains has neither the polarization demarcation membrane 331 nor the reflective film 332, but consists of only translucency members. Hereafter, suppose on explanation that this part 360 is called a translucent part. Moreover, about this translucent part 360, it mentions later.

[0038] In drawing 8 , the dummy section 370 which consists of translucency members is formed in the side-face (end face) part of the polarization sensing element 350 of the train of most left-hand side. Moreover, the edge 372 by the side of the plane of incidence (adhesion side) of the light of the dummy section 370 makes an angle round, or is having the angle taken. These reasons are explained later.

[0039] Drawing 9 is the explanatory view showing the example of manufacture of the polarization beam splitter array 340. This polarization beam splitter array 340 sticks by turns the sheet glass 321 with which the polarization demarcation membrane 331 and the reflective film 332 were formed, and the sheet glass 322 which is not formed at all with adhesives 325 so that the polarization demarcation membrane 331 and the reflective film 332 may be arranged by turns. Under the present circumstances, the sheet glass 322b (dummy section 370 (drawing 8)) and 322C (translucent part 360 (drawing 8)) of different thickness from sheet glass 322 is stuck on the beginning of lamination, and the last. If it carries out like this, the dummy section 370 and a translucent part 360 can be formed. In this way, a translucency block is started by cutting two or more pasted-up translucency members 321,322,322b and 322c almost in parallel by the front face and the cutting plane (a broken line showing among drawing) which makes the predetermined include angle theta. As for the value of theta, considering as about 45 degrees is desirable. Moreover, the part into which both ends projected is cut and it considers as an abbreviation rectangular parallelepiped configuration. In this way, by grinding the front face (cutting plane) of the started translucency block, the polarization beam splitter array 340 (drawing 8) can be obtained. In addition, in this specification, the block with which the "substrate" stuck a call and two or more translucency plates for the translucency plate (translucency member), and the block started from now on are also called "a substrate block."

[0040] a part of A-A' cross section which shows drawing 10 to drawing 5 -- it is an enlarged drawing. The polarization sensing-element arrays 320a and 320b are only arranged to the lens core in the symmetric position at the opposite sense, and since the function is completely the same, below, they explain polarization sensing-element array 320a. The effective incidence field EA (plane of incidence of the light corresponding to the polarization demarcation membrane 331) as for which the light which carries out incidence of the plane of incidence of the light of polarization sensing-element array 320a to the polarization demarcation membrane 331, and is changed into an effective polarization light carries out incidence, and the invalid incidence field UA (plane of incidence of the light corresponding to the reflective film 332) the light which carries out incidence to the reflective film 332, and is changed into an invalid polarization light carries out [the field] incidence are arranged by turns. Magnitude Wp of the x directions of this effective incidence field EA and the invalid incidence field UA Magnitude WL of the x directions of a condenser lens 311 It is made equal to one half. Moreover, core 311c of a condenser lens 311 is arranged so that it may become equal to the core of the x directions of the effective incidence field EA. Here, let effective polarization light changed and used by the polarization sensing element be s-polarized light light.

[0041] Incidence of the light (light which has the random polarization direction containing an s-polarized light component and a p-polarized light component) condensed by the condenser lens array 310 is carried out to polarization sensing-element array 320a. Among such incident light, the flux of light L1 which carries out incidence to the effective incidence field EA is divided into s-polarized light light and p-polarized light light by the polarization demarcation membrane 331, as previously explained using drawing 3 . It reflects by the polarization demarcation membrane 331, and outgoing radiation of the s-polarized light light is further reflected and carried out by the reflective film 332. P-polarized light light penetrates the polarization demarcation membrane 331, further, with lambda / 2 phase-contrast plate 381, is changed into s-polarized light light, and carries out outgoing radiation. Therefore, the light which carried out incidence to the effective incidence field EA of polarization sensing-element array 320a is mostly changed into s-polarized light light altogether, and carries out outgoing radiation.

[0042] In addition, if lambda / 2 phase-contrast plate 381 is alternatively formed in the outgoing radiation side side of

the reflective film 332, outgoing radiation only of the p-polarized light light can almost be alternatively carried out from a polarization sensing element.

[0043] The light which carries out incidence to the invalid incidence field UA is changed into an unnecessary polarization light (this example p-polarized light light) as the Prior art explained. Usually, a gobo etc. is prepared on the invalid incidence field UA, and since it is carrying out [intercept / light], the use effectiveness of light will fall. Since the quantity of light near a light source optical axis becomes the largest, when the invalid incidence field UA near an optical axis exists, decline in the use effectiveness of light is remarkable in a configuration like the polarization lighting system 50 especially shown in drawing 1 . This invention solves an above-mentioned problem and explains the detail below.

[0044] In this example, polarization sensing-element 350a (refer to drawing 10) nearest to the optical axis of polarization sensing-element array 320a and polarization sensing-element 350b nearest to the optical axis of polarization sensing-element array 320b (drawing 10) are considering as the configuration arranged on both sides of spacing Cp at the opposite sense at right and left. The dummy section 370 of two polarization sensing-element arrays 320a and 320b and the clearance Gp between these exist in this spacing Cp. The flux of light L2 which cannot irradiate the polarization demarcation membrane 331 since it cannot condense by the condenser lens array 310 by this among the flux of lights which carried out incidence to the condenser lens array 310 near the optical axis will pass the spacing Cp which neither the polarization demarcation membrane 331 nor the reflective film 332 has, and it will carry out [flux of light] outgoing radiation as it is. The passage light of this spacing Cp is the flux of light containing the s-polarized light light which is an effective polarization light, and the p-polarized light light which is an invalid polarization light. And using as the effective flux of light is possible among the outgoing radiation light which passes this spacing Cp by preparing a polarizing plate only for a required polarization light (this example s-polarized light light) at the outgoing radiation side side of this spacing Cp. Moreover, when the polarization lighting system 50 (drawing 1) is applied to the projection mold indicating equipment mentioned later, the polarizing plate is usually prepared in the plane of incidence of the liquid crystal light valve which is the lighting field 80. Therefore, in such a case, it is not necessary to prepare a polarizing plate separately.

[0045] The translucent part 360 which is the maximum outside of polarization sensing-element array 320a is a part which the light from the lens of the maximum outside of the condenser lens array 310 passes. Since the light source of the polarization lighting system 50 constituted using this example is usually arranged on a center line perpendicular to the plane of incidence of light at the core of the plane of incidence of the light of the condenser lens array 310 (refer to drawing 4), the outside of the lens array 310, i.e., the light by which incidence is carried out to this translucent part 360, has the smallest quantity of light. In such a condition, there is almost no difference in the quantity of light which can be effectively used by the 1st optical element 300 (drawing 1) whole by the case where it uses as a polarization light into which the incident light from the maximum outside of this condenser lens array 310 was changed by the polarization sensing element, and the case where it uses as it is without changing in many cases. Then, this translucent part 360 corresponding to the maximum outside of the condenser lens array 310 in polarization sensing-element array 320a was considered as the configuration of only a translucency member, without considering as the configuration of the polarization sensing element 350 (refer to drawing 8), and has also deleted lambda / 2 phase-contrast plate 381. By this, the flux of light L3 which passes the lens of the maximum outside of the condenser lens array 310 will pass this translucent part 360, and it will carry out [flux of light] outgoing radiation as it is. And the outgoing radiation light which carries out outgoing radiation from this translucent part 360 is the flux of light containing the outgoing radiation light which passes and carries out outgoing radiation of the above-mentioned spacing Cp, the s-polarized light light which is an effective polarization light similarly, and the p-polarized light light which is an invalid polarization light. And it is possible to use only a required polarization light (this example s-polarized light light) among the outgoing radiation light which passes this translucent part 360 as the flux of light more effective in preparing a polarizing plate in the outgoing radiation side side of this translucent part 360.

[0046] Drawing 11 is the explanatory view expanding and showing the edge 372 by the side of the plane of incidence of the light of the dummy section 370 shown in drawing 8 , and the dummy section 370. As shown in drawing 11 (A), the polarization sensing-element arrays 320a and 320b which do not have the dummy section 370 presuppose that the predetermined spacing Cp is prepared and arranged to the lens longitudinal direction core CL of the outgoing radiation side of the light of the condenser lens array 310. Although the optical path lengths will differ by the flux of light which passes spacing Cp, and the flux of light which passes the polarization sensing-element arrays 320a and 320b at this time, if possible, it is desirable to make the optical path length equal as much as possible. Moreover, the flux of light Lex1 reflected by the end face 371 of the polarization sensing-element arrays 320a and 320b Depending on the direction of reflective, it may be unable to use effectively. Moreover, the condenser lens array 310 and the polarization sensing-

element arrays 320a and 320b are pasted up with adhesives 375, as shown in drawing 11 (A). At this time, the flash section 376 of adhesives occurs at the predetermined spacing Cp. The flux of light Lex2 which passes the flash section 376 of such adhesives It will reflect irregularly with the heterogeneity on the front face of adhesives, and can use effectively.

[0047] Then, as shown in drawing 11 (B), we decided to form the dummy section 370 by the translucency member 323 which constitutes the polarization sensing-element arrays 320a and 320b at the predetermined spacing Cp, and the same member. if it carries out like this -- the reflected light Lex1 in the above-mentioned optical path length's problem, and the end face 371 of the polarization sensing-element arrays 320a and 320b A problem can be eased. Moreover, as shown in drawing 11 (B), while forming the dummy section 370, we decided to lessen the flash of adhesives by making round the angle of the edge 372 by the side of the plane of incidence (adhesion side) of the light of the dummy section 370, or taking an angle. In addition, there may not be the clearance Gp between cores. However, when the alignment precision of the adhesion location in the case of pasting up the polarization sensing-element arrays 320a and 320b on the outgoing radiation side of the condenser lens array 310 was taken into consideration and the polarization sensing-element arrays 320a and 320b are pasted up on the outgoing radiation side of the condenser lens array 310, it is desirable to form the dummy section 370 in a core with extent which can do the clearance Gp between some.

[0048] C. The 2nd example : drawing 12 is the explanatory view showing optical element 300' of the 2nd example.

[0049] In a configuration like the polarization lighting system 50 (drawing 1), quantity of light distribution of the light which is condensed by each lens La-Ld of the lens array 310, and irradiates the plane of incidence of polarization sensing-element array 320a' is shown in the middle of drawing 12 . Generally, the optical reinforcement Ia of the light condensed with the lens La nearest to an optical axis becomes the strongest, the light condensed with a lens far from an optical axis becomes weak, and the optical reinforcement Id of the light condensed with the 4th lens Ld becomes the weakest in drawing 12 . Moreover, bordering on a certain lens location (drawing 12 location of the 3rd lens Lc), quantity of light distribution of the light condensed by each lens La-Ld turns into distribution of optical-axis approach to a lens core, so that it is close to an optical axis, and it turns into distribution of the opposite approach of an optical axis, so that it is far from an optical axis. In drawing 12 , centering on a lens, it is distributed mostly, and the quantity of light distribution Pc of the light condensed with Lens Lc is turning into distribution of optical-axis approach to the quantity of light distribution Pb and Pa gradually, so that it is close to Lenses Lb and La and an optical axis. Moreover, the quantity of light distribution Pd of the light condensed with Lens Ld is the opposite approach of an optical axis.

[0050] In such a case, if the core of the effective incidence field of a polarization sensing-element array is uniformly made in agreement with a lens core, loss of the light resulting from a gap of the above quantity of light distribution will occur. Especially the gap with the distribution and the effective incidence field of light by which outgoing radiation is carried out from a lens array in near a light source optical axis serves as loss of a big light. Therefore, it is desirable to arrange the core of each effective incidence field of polarization sensing-element array 320a' according to peak spacing of the distribution of light by which outgoing radiation is carried out from the lens array 310 according to the distribution of light by which outgoing radiation is carried out from the lens array 310. Moreover, in order to use more effectively the light condensed by the lens array 310, it is desirable that the light condensed with the lens near an optical axis enables it to use more effectively. The quantity of light near a light source optical axis is large especially, and when the distribution Pa of the light by which outgoing radiation is carried out from the lens La near a light source optical axis inclines toward the light source optical-axis side rather than the main optical axis of a lens, it is desirable to double mostly the core of the effective incidence field EA1 nearest to a light source optical-axis side of polarization sensing-element array 320a' with the peak location of the distribution Pa of light.

[0051] The 2nd example is a thing corresponding to optical reinforcement or quantity of light distribution which has a dependency over the above lens locations of a condenser lens array and to carry out. although optical element 300' of the 2nd example is the same configuration as the 1st example fundamentally -- the width of face Wp of the x directions of the effective incidence field EA (inside EA1-EA4 of drawing), and the invalid incidence field UA (inside UA1-UA4 of drawing) -- ' -- width of face WL of the x directions of each lens La-Ld of the lens array 310 Larger polarization sensing-element array 320a' than one half differs from the point of using 320b'. Drawing 12 shows only the polarization sensing-element array 320a' side among these. On the basis of the optical axis, since it was only as symmetrical as the polarization sensing-element array 320a side, the polarization sensing-element array 320b' side was omitted.

[0052] For example, polarization sensing-element array 320a' is arranged so that the core of the lens Lc of eye three trains and the core of the effective incidence field EA3 corresponding to it may be made equal. Usually, since the width of face UA (from UA1 to UA [Drawing]4) of an invalid incidence field is equal to width-of-face Wp' of the effective incidence field EA, two left-hand side effective incidence fields EA2 and EA1 serve as optical-axis approach gradually to the core of each lenses Lb and La. Moreover, the effective incidence field EA4 of most right-hand side serves as

opposite approach of an optical axis to the core of Lens Ld. Consequently, each effective incidence fields EA1-EA4 are mostly in agreement with the location of the quantity of light distribution of light by which outgoing radiation is carried out from the lens array 310. Since optical reinforcement is strong, especially a predetermined number near an optical axis of lenses, for example, 2-3 lenses, it is desirable to quantity of light be [of the light condensed with these lenses] distribution and that the effective incidence field corresponding to it is mostly in agreement. By making it such a configuration, the 2nd example can raise the use effectiveness of light more. In addition, it is experimentally called for easily from the number of lens arrays, and the relation of the quantity of light distribution corresponding to each lens how much width of face of an effective incidence field is enlarged to one half of the width of face of a lens and whether it arranges on the basis of the effective incidence field to which lens. Moreover, it is not necessary to limit the width of face of an effective incidence field or an invalid incidence field to making it larger than one half of the width of face of a lens, and it is determined by the actual quantity of light distribution which irradiates the plane of incidence of the light of a polarization sensing-element array.

[0053] D. Projection mold display drawing 13 is the outline block diagram showing the important section of the projection mold display 800 equipped with the polarization lighting system 50 shown in drawing 1 . This projection mold display 800 is equipped with the polarization lighting system 50, a dichroic mirror 801,804, the reflective mirror 802,807,809, the relay lens 806,808,810, the liquid crystal light valve 803,805,811 of three sheets, the cross dichroic prism 813, and the projection lens 814.

[0054] A dichroic mirror 801,804 has a function as a colored light separation means to divide a white light bundle into the colored light of red, blue, and three green colors. The liquid crystal light valve 803,805,811 of three sheets has a function as a light modulation means to modulate the colored light of three colors, respectively and to form an image, according to the given image information (picture signal). The cross dichroic prism 813 has a function as a colored light composition means to compound the colored light of three colors and to form a color picture. The projection lens 814 has a function as projection optical system which projects the light showing the compounded color picture on a screen 815.

[0055] The blue light green light reflex dichroic mirror 801 reflects a blue glow component and a green light component while making a part for red Mitsunari of the white light bundle by which outgoing radiation was carried out from the polarization lighting system 50 penetrate. It is reflected by the reflective mirror 802 and a transmitted red light reaches the liquid crystal light valve 803 for red sunset. On the other hand, among the blue glow and green light which were reflected with the 1st dichroic mirror 801, it is reflected by the green light reflex dichroic mirror 804, and green light reaches the liquid crystal light valve 805 for ****. On the other hand, blue glow also penetrates the 2nd dichroic mirror 804.

[0056] In this example, the optical path length of blue glow becomes the longest among three colored light. Then, to blue glow, the light guide means 850 which consisted of relay lens systems containing the incidence lens 806, a relay lens 808, and the outgoing radiation lens 810 is established after the dichroic mirror 804. That is, after blue glow penetrates the green light reflex dichroic mirror 804, it is first led to a relay lens 808 through the incidence lens 806 and the reflective mirror 807. Furthermore, it is reflected by the reflective mirror 809, and is led to the outgoing radiation lens 810, and the liquid crystal light valve 811 for blue lights is reached. In addition, the liquid crystal light valve 803,805,811 of three sheets is equivalent to the lighting field 80 in drawing 7 .

[0057] According to the picture signal (image information) given from the control circuit of the exterior which is not illustrated, three liquid crystal light valves 803, 805, and 811 modulate each colored light, and generate the colored light containing the image information of each color component. Incidence of the three modulated colored light is carried out to the cross dichroic prism 813. The dielectric multilayers which reflect red sunset in the cross dichroic prism 813, and the dielectric multilayers which reflect a blue light are formed in the shape of a cross joint. Three colored light is compounded by these dielectric multilayers, and the light showing a color image is formed. With the projection lens 814 which is projection optical system, the compounded light is projected on a screen 815, and an image is expanded and it is displayed.

[0058] In this projection mold display 800, the liquid crystal light valve 803,805,811 of the type which modulates the flux of light (s-polarized light light or p-polarized light light) of the specific polarization direction as a light modulation means is used. Usually in these liquid crystal light valves, the polarizing plate (not shown) is stuck on an incidence and outgoing radiation side, respectively. Therefore, it is modulated, predetermined polarization direction, for example, s-polarized light light, and incidence is carried out to the cross dichroic prism 813. At this time, as shown also in drawing 5 mentioned above, outgoing radiation of the flux of light which was condensed by the condenser lens array 310 among the flux of lights by which incidence was carried out to the optical element 300, and irradiated the polarization demarcation membrane 331 is altogether changed and carried out to s-polarized light light. The flux of light by which

outgoing radiation was carried out from the optical element 300 illuminates the liquid crystal light valve 803,805,811 with the outgoing radiation side lens 390.

[0059] Moreover, without the ability condensing by the condenser lens array 310 among the flux of lights by which incidence was carried out to the optical element 300, as the Prior art explained, outgoing radiation of the flux of light which irradiated the reflective film 332 is changed and carried out to p-polarized light light, and it illuminates the liquid crystal light valve 803,805,811. However, as mentioned above, the polarizing plate is prepared in it in order to use only s-polarized light light for the plane of incidence of the liquid crystal light valve 803,805,811, as mentioned above, and p-polarized light light is intercepted. On the other hand, outgoing radiation of the flux of light which passed the spacing Cp (drawing 10) in the optical element 300 by the example of this invention is carried out without being changed into polarization light, and it illuminates the liquid crystal light valve 803,805,811. Since this illumination light is the white light which contains a part for available s-polarized light Mitsunari with the liquid crystal light valve 803,805,811, it can use only a part for s-polarized light Mitsunari of the light which irradiated the liquid crystal light valve 803,805,811. Therefore, since the polarization lighting system 50 using the optical element 300 by the example is being used for the projection mold display 800 shown in drawing 13 , it has the advantage that the use effectiveness of light is higher than before.

[0060] As mentioned above, the use effectiveness of the light in a projection mold display can be raised by using the optical element by this example compared with the former. Therefore, the image projected on a screen 815 can be made brighter.

[0061] In addition, this invention can be carried out in various modes in the range which is not restricted to an above-mentioned example or an above-mentioned operation gestalt, and does not deviate from that summary, for example, the following deformation is also possible for it.

[0062] The polarization lighting system by this invention can be applied not only to the projection mold display shown in drawing 13 but to various equipments other than this. For example, the polarization beam splitter array by this invention is applicable also to the projection mold indicating equipment which projects not a color picture but monochrome image. In this case, in the equipment of drawing 13 , a colored light separation means for a liquid crystal light valve to be managed with one sheet, and to divide the flux of light into three colors, and a colored light composition means to compound the flux of light of three colors are omissible. Furthermore, this invention is applicable also to the projection mold electrochromatic display with which only one uses a light valve. Moreover, it is applicable also to the image display device using polarization illumination light, such as a projection mold display using the light valve of a reflective mold, and a rear mold display.

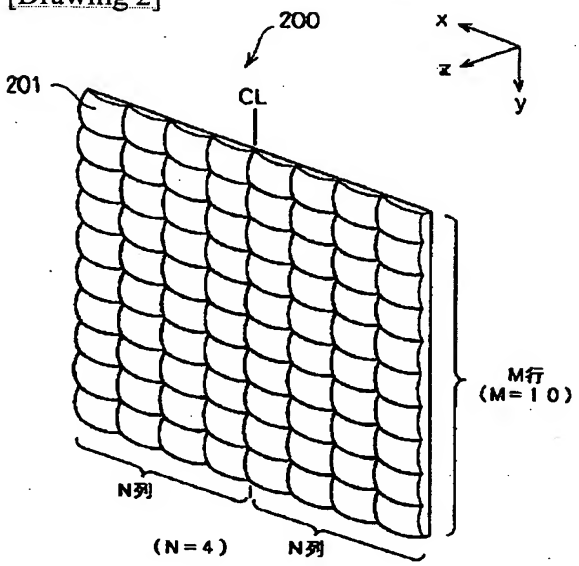
[Translation done.]

* NOTICES *

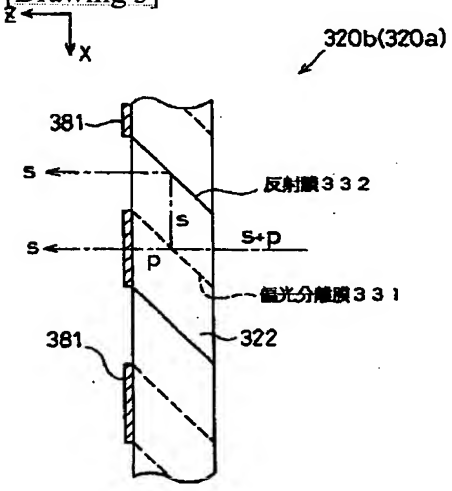
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

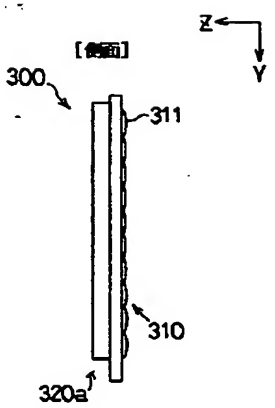
[Drawing 2]



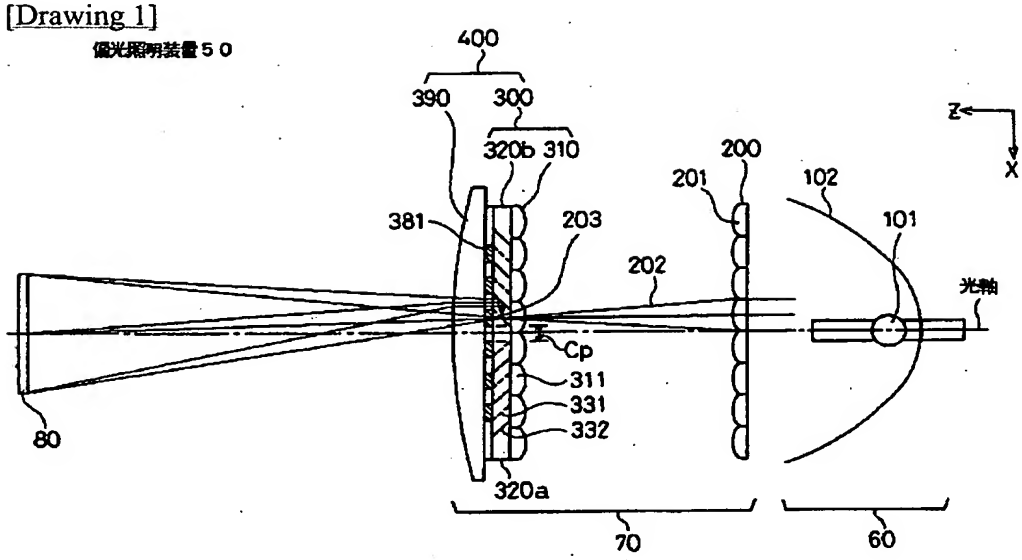
[Drawing 3]



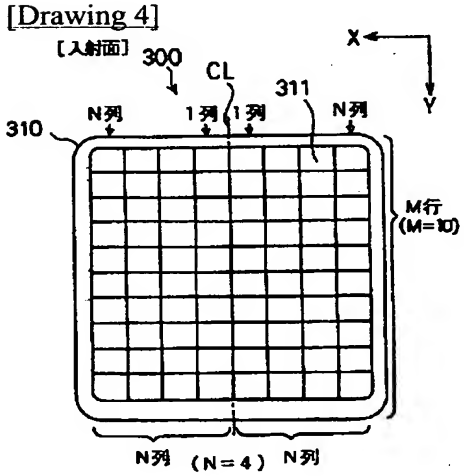
[Drawing 7]



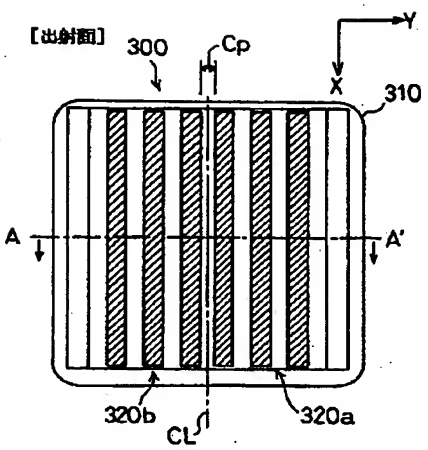
[Drawing 1]



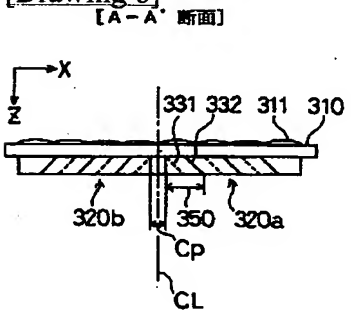
[Drawing 4]



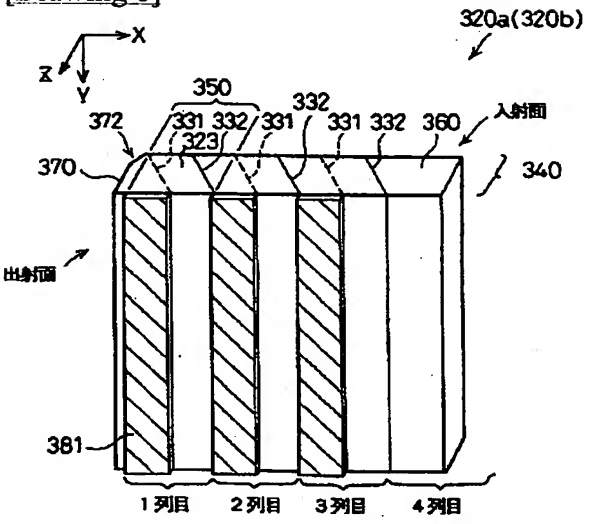
[Drawing 5]



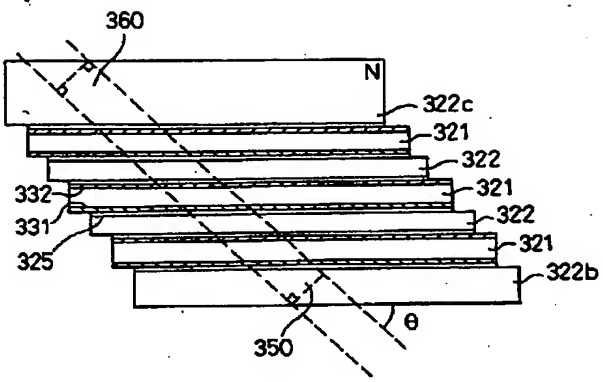
[Drawing 6]



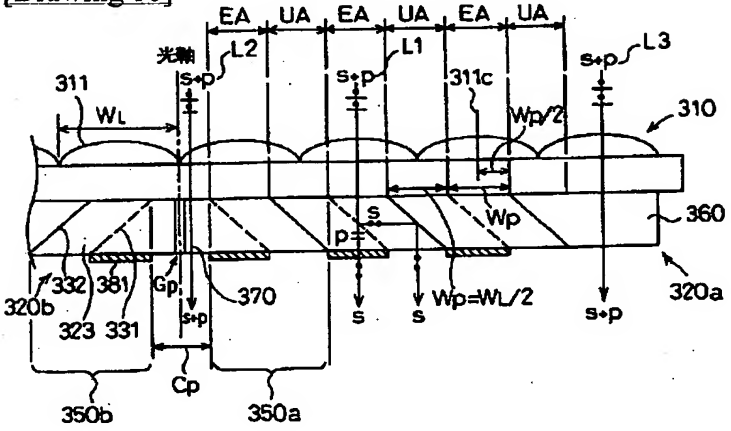
[Drawing 8]



[Drawing 9]

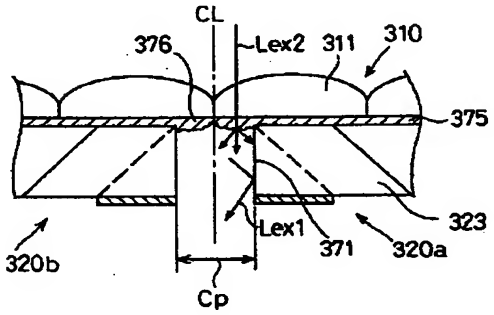


[Drawing 10]

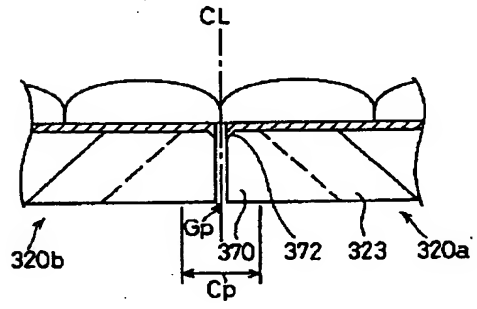


[Drawing 11]

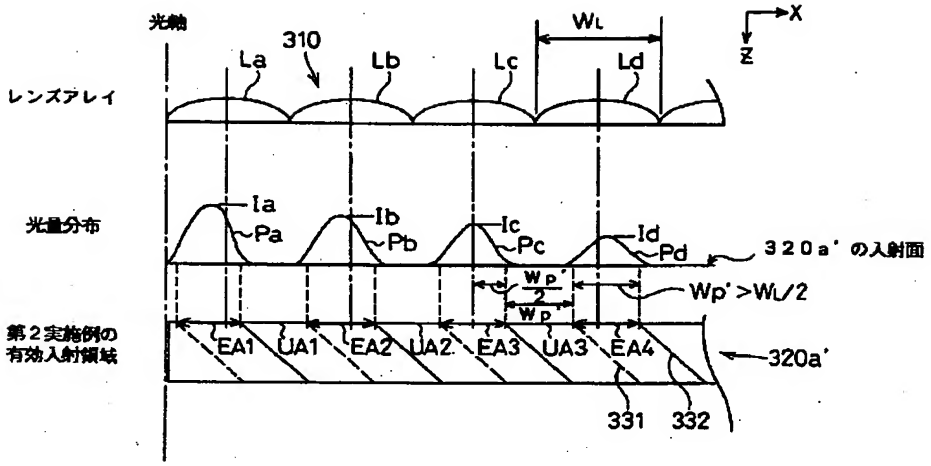
(A)



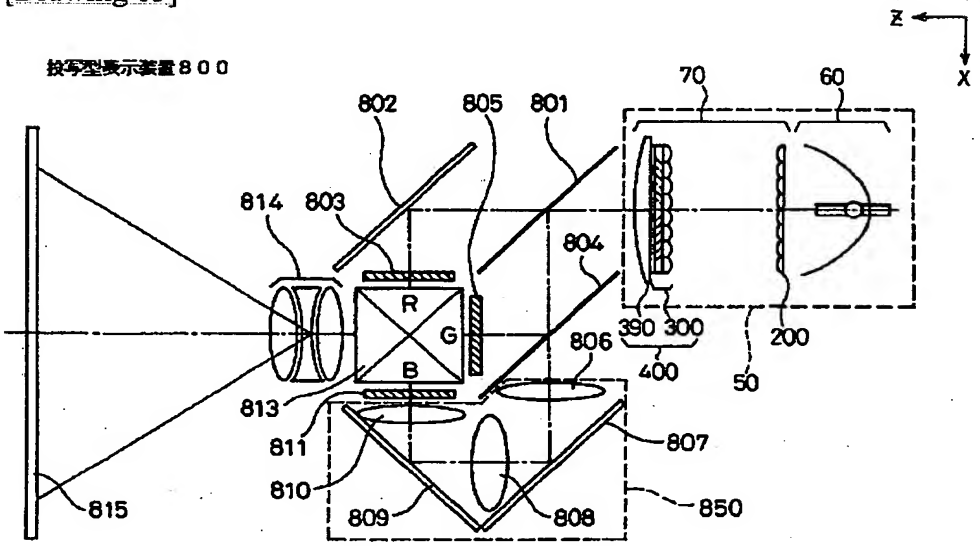
(B)



[Drawing 12]

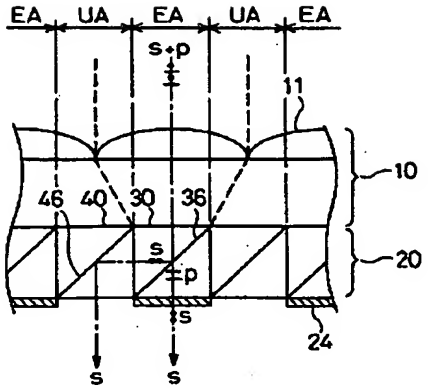


[Drawing 13]

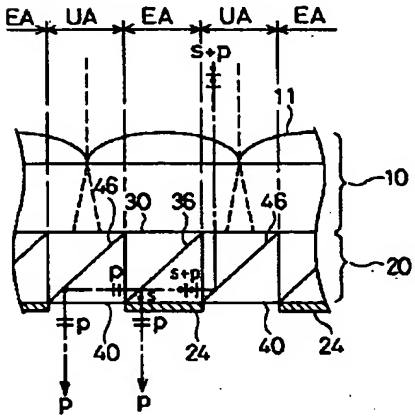


[Drawing 14]

(A)



(B)



[Translation done.]

* NOTICES *

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 6th section
[Publication date] February 9, Heisei 13 (2001. 2.9)

[Publication No.] JP,10-177151,A
[Date of Publication] June 30, Heisei 10 (1998. 6.30)
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[Application number] Japanese Patent Application No. 8-354364
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G02B 27/28
5/30
G02F 1/13 505
1/1335 530

[FI]

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5/30
G02F 1/13 505
1/1335 530

[Procedure revision]
[Filing Date] March 16, Heisei 12 (2000. 3.16)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] The name of invention
[Method of Amendment] Modification
[Proposed Amendment]
[Title of the Invention] Optical element
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light,
Each of said polarization sensing-element array is equipped with the polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, and the reflector in which one side is reflected among the linearly polarized light light from which said polarization separation side dissociated, and two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member,
Said two polarization sensing-element arrays are optical elements characterized by being arranged and becoming so that

predetermined spacing may be separated and said mutual polarization separation side may face each other.
[Claim 2] In claim 1,
The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 3] In claims 1 or 2,
The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 4] The lens array by which two or more lenses have been arranged,
It is fixed to one field of said lens array, and has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light,
Each of said polarization sensing-element array is equipped with the polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, and the reflector in which one side is reflected among the linearly polarized light light from which said polarization separation side dissociated, and two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member,
Said two polarization sensing-element arrays are optical elements characterized by being arranged and becoming so that predetermined spacing may be separated and said mutual polarization separation side may face each other.
[Claim 5] In claim 4,
The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 6] In claim 5,
The optical element characterized by removing the corner by the side of said predetermined spacing of said dummy area.
[Claim 7] In claim 4 thru/or either of 6,
The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 8] In claim 4 thru/or either of 7,
The optical element characterized by the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector being larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector.
[Claim 9] It is the optical element which the polarization direction is equipped with the polarization separation side which divides a random polarization light into two kinds of linearly polarized light light, and the reflector in which one side is reflected among the linearly polarized light light from which said polarization separation side dissociated, and comes to carry out two or more arrangement of said polarization separation side and said polarization reflector by turns through a translucency member,
The optical element characterized by a translucency member coming to form in one [at least] edge the dummy area where neither said polarization separation side nor said polarization reflector exists.
[Claim 10] The optical element characterized by coming to fix to one field of an optical element according to claim 9 the lens array by which two or more lenses have been arranged.
[Claim 11] In claim 9 or claim 10,
The optical element characterized by removing the corner of said dummy area.
[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0001
[Method of Amendment] Modification
[Proposed Amendment]
[0001]
[Field of the Invention] This invention relates to the optical element which changes into the predetermined polarization flux of light the light by which incidence was carried out.
[Procedure amendment 4]

[Document to be Amended] Specification
[Item(s) to be Amended] 0017
[Method of Amendment] Modification
[Proposed Amendment]
[0017] The polarization separation side where the 3rd invention divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which one side is reflected among the linearly polarized light light separated by said polarization separation side. Said polarization separation side and said polarization reflector are the optical element which comes to carry out two or more arrangement by turns through a translucency member, and the dummy area where neither said polarization separation side nor said polarization reflector exists in one [at least] edge is characterized by a translucency member coming to be formed.
[Procedure amendment 5]
[Document to be Amended] Specification
[Item(s) to be Amended] 0018
[Method of Amendment] Modification
[Proposed Amendment]
[0018] According to the 3rd invention, the same operation and effectiveness as the 1st above-mentioned invention can be acquired.
[Procedure amendment 6]
[Document to be Amended] Specification
[Item(s) to be Amended] 0019
[Method of Amendment] Modification
[Proposed Amendment]
[0019] The lens array by which two or more lenses have been arranged may be made to be fixed here to one field of the optical element of invention of the above 3rd.
[Procedure amendment 7]
[Document to be Amended] Specification
[Item(s) to be Amended] 0020
[Method of Amendment] Modification
[Proposed Amendment]
[0020] If it does in this way, the same operation and effectiveness as the 2nd above-mentioned invention can be acquired.
[Procedure amendment 8]
[Document to be Amended] Specification
[Item(s) to be Amended] 0021
[Method of Amendment] Modification
[Proposed Amendment]
[0021] In addition, in each configuration of invention of the above 3rd, the corner of said dummy area may be made to be removed.
[Procedure amendment 9]
[Document to be Amended] Specification
[Item(s) to be Amended] 0022
[Method of Amendment] Modification
[Proposed Amendment]
[0022] If it does in this way, it sticks with other optical elements, and in case it fixes, the flash of the adhesives used can be absorbed in the space in which it is prepared by the corner.
[Procedure amendment 10]
[Document to be Amended] Specification
[Item(s) to be Amended] 0023
[Method of Amendment] Deletion

[Translation done.]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 6th section
[Publication date] January 18, Heisei 14 (2002. 1.18)

[Publication No.] JP,10-177151,A
[Date of Publication] June 30, Heisei 10 (1998. 6.30)
[Annual volume number] Open patent official report 10-1772
[Application number] Japanese Patent Application No. 8-354364
[The 7th edition of International Patent Classification]

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[FI]

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G02F 1/13 505
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[Procedure revision]
[Filing Date] August 1, Heisei 13 (2001. 8.1)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[Proposed Amendment]
[Claim(s)]
[Claim 1] It has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light,
Each of said polarization sensing-element array is equipped with the polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, and the reflector in which the linearly polarized light light in which it was reflected by said polarization separation side is reflected, and two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member,
Said two polarization sensing-element arrays are optical elements characterized by being arranged so that said mutual polarization separation side may face each other, and for the polarization separation sides by the side of a core separating predetermined spacing of said two polarization sensing-element arrays, and arranging them most.
[Claim 2] In claim 1,
The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.

[Claim 3] In claims 1 or 2,
The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 4] The lens array by which two or more lenses have been arranged,
It is fixed to one field of said lens array, and has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light,
Each of said polarization sensing-element array is equipped with the polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, and the reflector in which the linearly polarized light light in which it was reflected by said polarization separation side is reflected, and two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member,
Said two polarization sensing-element arrays are optical elements characterized by being arranged so that said mutual polarization separation side may face each other, and for the polarization separation sides by the side of a core separating predetermined spacing of said two polarization sensing-element arrays, and arranging them most.
[Claim 5] In claim 4,
The optical element characterized by forming the dummy area where neither said polarization separation side nor said reflector exists in said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 6] In claim 5,
The optical element characterized by removing the corner by the side of said predetermined spacing of said dummy area.
[Claim 7] In claim 4 thru/or either of 6,
The optical element characterized by forming the field where neither said polarization separation side nor said reflector exists in the side which is not said predetermined spacing side among each both ends of said two polarization sensing-element arrays by the translucency member.
[Claim 8] In claim 4 thru/or either of 7,
The optical element characterized by the array pitch of said polarization separation side in alignment with the optical plane of incidence of said polarization sensing-element array and said reflector being larger than one half of the array pitches of said lens array which met in the array direction of said polarization separation side and said reflector.
[Claim 9] It is the optical element which the polarization direction is equipped with the polarization separation side which divides a random polarization light into two kinds of linearly polarized light light, and the reflector in which the linearly polarized light light in which it was reflected by said polarization separation side is reflected, and comes to carry out two or more arrangement of said polarization separation side and said polarization reflector by turns through a translucency member,
The optical element characterized by a translucency member coming to form in one [at least] edge the dummy area where neither said polarization separation side nor said polarization reflector exists.
[Claim 10] The optical element characterized by coming to fix to one field of an optical element according to claim 9 the lens array by which two or more lenses have been arranged.
[Claim 11] In claim 9 or claim 10,
The optical element characterized by removing the corner of said dummy area.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0007
[Method of Amendment] Modification
[Proposed Amendment]
[0007]
[The means for solving a technical problem, and its operation and effectiveness] In order to solve an above-mentioned technical problem, the 1st invention is an optical element and it has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. The polarization separation side where each of said polarization sensing-element array divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which the linearly polarized light light reflected by said polarization separation side is reflected. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member. Said two polarization sensing-element

arrays It is characterized by being arranged so that said mutual polarization separation side may face each other, and for the polarization separation sides by the side of a core separating predetermined spacing of said two polarization sensing-element arrays, and being arranged most.

[Procedure amendment 3]
[Document to be Amended] Specification
[Item(s) to be Amended] 0013
[Method of Amendment] Modification
[Proposed Amendment]
[0013] The lens array by which the 2nd invention is an optical element and two or more lenses have been arranged in the shape of a matrix, It is fixed to one field of said lens array, and has two polarization sensing-element arrays which change polarization light with the random polarization direction into one kind of polarization light. Each of said polarization sensing-element array The polarization separation side which divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which the linearly polarized light light reflected by said polarization separation side is reflected. Two or more arrays of said polarization separation side and said reflector are carried out by turns through a translucency member. Said two polarization sensing-element arrays It is characterized by being arranged so that said mutual polarization separation side may face each other, and for the polarization separation sides by the side of a core separating predetermined spacing of said two polarization sensing-element arrays, and being arranged most.

[Procedure amendment 4]
[Document to be Amended] Specification
[Item(s) to be Amended] 0017
[Method of Amendment] Modification
[Proposed Amendment]
[0017] The polarization separation side where the 3rd invention divides polarization light with the random polarization direction into two kinds of linearly polarized light light, It has the reflector in which the linearly polarized light light reflected by said polarization separation side is reflected. Said polarization separation side and said polarization reflector are the optical element which comes to carry out two or more arrangement by turns through a translucency member, and the dummy area where neither said polarization separation side nor said polarization reflector exists in one [at least] edge is characterized by a translucency member coming to be formed.

[Translation done.]